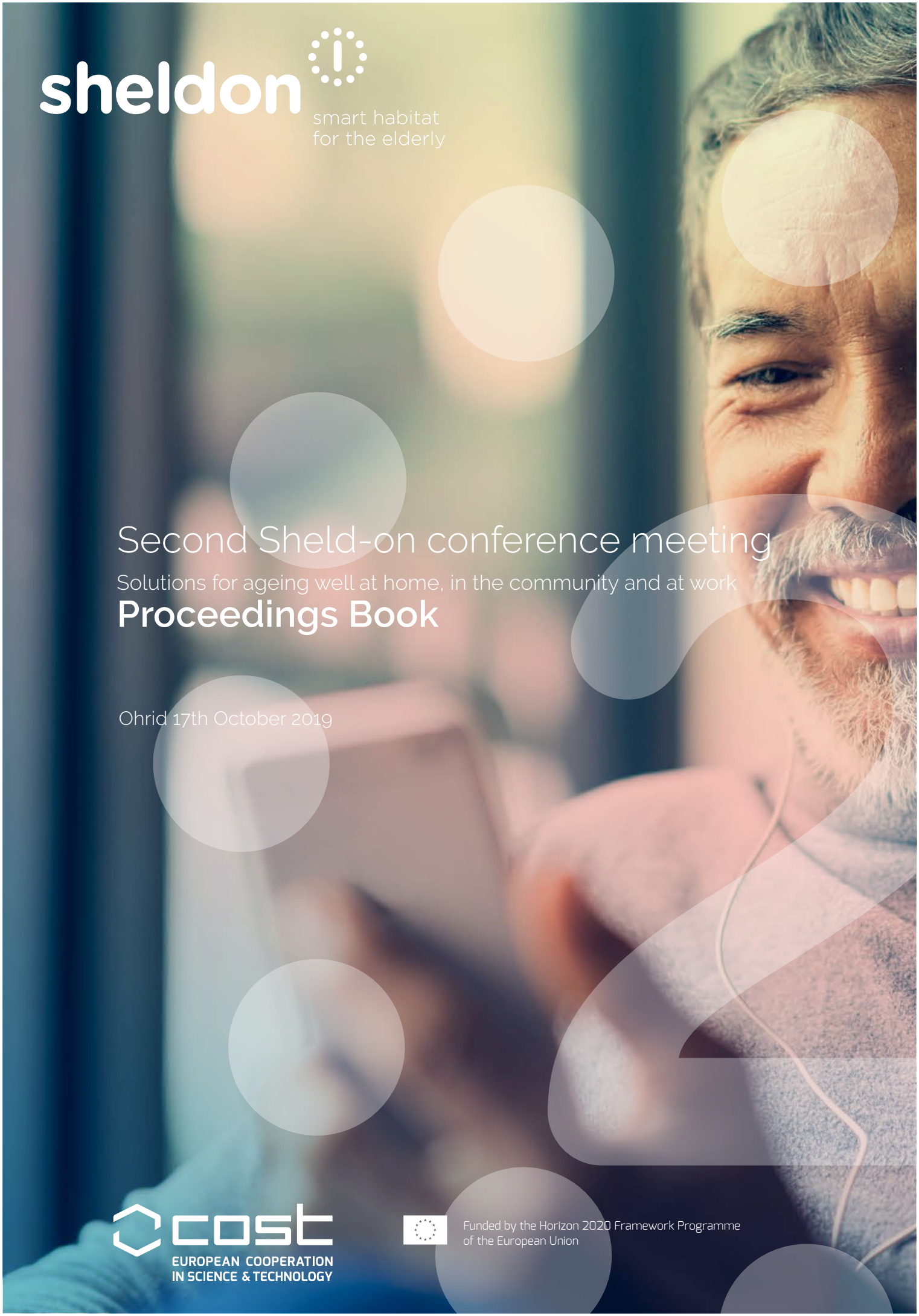
sheldon
smart habitat
for the elderly
Second Sheld-on conference meeting
Solutions for ageing well at home, in the community and at work
Proceedings Book
Ohrid 17th October 2019
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sheldon
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COST Action CA16226
Indoor living space improvement: Smart Habitat for the Elderly

Sheld-on
Furniture, Habitat, Active and Healthy Ageing, ICT, Healthcare

Proceedings of the COST Action CA16226 conference meeting,
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Technical Research Centre of Furniture and Wood of the Región of Murcia
CETEM

Preface

It is our pleasure to welcome you to the Second Sheld-on Conference Meeting promoted by the COST Action CA16226: "Indoor living space improvement: Smart habitat for the elderly". This time it will be held in Ohrid, North Macedonia, on the 17th of October, 2019, collocated with the 11th ICT Innovations Conference 2019.
This conference follows almost two years of active collaboration under three different working groups focused in vertical areas of knowledge. This paved the way for a new horizontal working group that aims for deeper interdisciplinary interactions and knowledge interchange considering the broad concept of "Solutions for Ageing Well". Due to its broad spectrum, its structure contains three subworking groups looking into narrower areas of application, specifically at home, work and the community. A fourth one focuses on the important topic of "Technology Adoption". The proceedings and conference parallel tracks reflect this new approach.

This conference brings together researchers not only from Sheld-on members, but also from other institutions that work in related fields, some of which bring results achieved during the Short Term Scientific Mission granted by Sheld-on during the last year. A total of 31 papers cover a wide range of topics within the scope of Sheld-on, including IoT, BIM, connected health, features of the elderly and their relation to technology, applications of robots, and many others such as social aspects, climate change and artificial intelligence. Each work has been peer-reviewed by two carefully selected experts.

This event will be a great opportunity not only to plan for the action work in the near future, but also to advance the Sheld-on collaborative effort to build new solutions that contribute to the well-being of older adults and their caretakers, while addressing the socioeconomics concerns related to a worldwide aging population.

We would like to thank the local organization staff from the Association for Information and Communication Technologies and the Sts. Cyril and Methodius University in Skopje, North Macedonia, the members of the scientific committee for their review work and suggestions for improving the papers, the authors for contributing their research results to the conference, and all Sheld-on members for supporting and publicising the event.

Special thanks to the COST association that has made possible all activities of the Sheld-on Action, including this conference, and has initiated other derived initiatives and fruitful collaborations.

On behalf of the core group,
Rafael Maestre, Working Group 4 Leader
Francisco Melero, Action Chair

Index

Solutions for ageing well at home

Solutions for ageing well in the community

Solutions for ageing well at work

Technology Adoption

Solutions for ageing well at home

Sub-Working Group 4.1 Proceedings

Vice-Leader: Prof. Jake Kaner (UK)

Second Sheld-on conference meeting
Proceedings Book

Telepresence mobile robot platform for elderly care

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Keywords:
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Recent demographic trends in most countries show that the percentage of elderly is rapidly increasing. According to the World Health Organization (WHO), by 2050, the number of people in the world who are aged over 60, is projected to grow more than double, from 605 million to 2 billion, representing 16% of the world's population.

These trends are introducing multiple challenges, including social, economic and cultural, not only to the elderly but, also for their families and the entire society. On the other hand, lack of qualified health care personnel, and the high level of expectancy of these services that should meet the demands for the elderly in order to prolong their independency, have already introduced increased burden in the health-care sector in many countries.

Ageing society is demanding technological solutions that will help to overcome these issues. Robotic assistants used in the elderly and the disabled care has emerged as a potential solution. Various personal service robots are already available on the market. Many of them such as: PEARL, CompanionAble, CareBot, Kompai, Care-o-Bot, PR2 (Sharkey and Sharkey, 2011) are designed to perform specific tasks including: manipulating objects, reminder for taking medications, maintaining a shopping list, as well as emergency notification, and navigation. In addition to the high cost, these robots have their own limitations, such as the absence of both social and healthcare capabilities, inability to pick-up objects from high shelves, as well as problems with thresholds, during indoor navigation (Koceska et al. 2019).

Figure 1: Developed assistive telepresence robot for elderly health care.

Having in mind these limitations of the existing solutions, we have designed and developed a low-cost assistive telepresence robot system for facilitating the health care of the elderly, and improving the quality of life of the elderly and handicapped (Figure 1). The developed robot was composed of four main functional hardware units: wheeled robot body capable of steer-steering,

robot body containing linear actuator, robot arm with 6 degrees of freedom (DOF), and robot head represented by a tablet and camera for remote communication.

Along with the smart navigation functionalities, the robot permits various interactions in a remote environment, like navigation, fetch and carry small objects, measuring vital parameters of an elderly person, reminder, calendar, and interpersonal communication. The potential users of the robot system are not only the elderly but, also professional caregivers. The robot can be remotely controlled by a distant person (e.g., a professional caregiver), and can perform some activities as if he/she was physically present at the elderly's residence (Koceska et al. 2019).

Robot's control architecture, various command interfaces (Koceski et al. 2012), (Koceski and Koceska 2010) as well as robot functionalities have been experimentally evaluated. Conducted evaluation studies demonstrated that the core functionalities provided by developed telepresence robot system are accepted by potential users (Koceski and Koceska 2016).

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BIM & AAL

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Building Information Modeling (BIM): the design and operation of buildings is today characterized by the concept of building information modeling in the professional world. The term BIM describes a planning method which, ideally, can digitally model, link and display all relevant building information over the entire lifecycle of a building. The actors involved, their responsibilities and their interaction are understood as an essential part of the processes modeled in BIM (Eastman 2011) . The term Ambient Assisted Living (AAL), on the other hand, summarizes methods, systems and services designed to enable people with reduced mobility to live as long as possible and independently in their entrusted environment. They are supported as discreetly as possible by electronic systems integrated in the living environment and concepts based on them (Rashidi, 2013). In recent years, the BIM method has proven to be a promising method for the efficient planning, achievement and operation of buildings. It can be seen as a consistent continuation of the digitalization of house planning and benefits from earlier developments in the automotive industry. Buildings, however, differ in some essential respects from the manufacture of other industrial products. They are always unique, are characterised by a very high number of players involved, have an exceptionally long service life as products and must be able to adapt constantly to the changing requirements of their users during this time. It is the interaction with users in particular that presents buildings with constantly growing challenges. In particular, rapidly changing technical infrastructure developments (e.g. Smart House) and changing user profiles due to social changes play a decisive role here. In this context, demographic development is crucial: more and more people are expressing the desire to be able to remain as self-determined as possible in their old age in their familiar living spaces and to be able to lead as independent a life as possible even with limited mobility and motoric functions.

These considerations give rise to three central questions for the training of construction experts: what requirements arise from these processes for future buildings? Why can the principles of the BIM and AAL methods support this process well? How should a didactic system be structured that can effectively support these requirements?

What are the requirements for the construction processes and for the buildings themselves?

- Buildings must be able to react flexibly and effectively to social and technical changes. The possibility of adaptation must primarily be shown in the flexible design of floor plans and result in individually designable and scalable spaces.
- In the future, buildings must be able to interact with their users automatically at a high level. This requires a sophisticated system of sensors and actors.
- Automation must be configurable and responsive to the individual needs of each user.

The BIM method offers best conditions for supporting an interdisciplinary and heterogeneous working group in the planning of a complex unique product. It builds a consistent and com-

prehensive digital data model and ideally manages all relevant semantic information about materials, procedures, processes and actors involved, in addition to the geometric-spatial information. The data basis can be kept in open source formats and made accessible to the actors on a rule-based basis. The requirements of Ambient Assisted Living concepts can be integrated both technically and methodically into BIM.

Buildings that have to meet these requirements have particularly high demands on the interaction of planners and their training. This training can only succeed if it has the following properties:

- The accumulation of theoretical knowledge alone is not sufficient to meet the interdisciplinary requirements of these new planning tasks.
- The planners must take on different roles as planners and stakeholders in group work and train their ability to act in an interdisciplinary environment.
- The training must initiate a significant change in the way the participants work. Open cooperation and joint action should replace the solitary way of working that is common today.
- The cooperation must take place already in early planning phases, since the possibilities for influencing the construction processes are greatest.
- Due to the rapid development of technological issues, experts must be able to quickly acquire new knowledge and be ready for lifelong learning and learning on demand concepts.

The combination of BIM and AAL methods is currently being set up to an open learning platform in the EU-funded Erasmus+ project ESSENSE (Essense 2019).

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Interactive textiles for designing adaptive space for elderly

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Keywords:
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Interdisciplinary research between interior design, textile materials and health care staff, is focused on the different functional qualities and aesthetics of an interior space with interactive textiles, such as the conception of furniture adapted physically and psychologically for elderly by taking into account some criteria and components like accessibility, sound regulation, music therapy, luminopharia, comfort, thermal, usability, ..
In this the study we will present some initiatives recently developed of smart textile for elderly, we will determine the potential of interactive textiles used for designing multi-sensory environments and their effects on the treatment and therapy of the dementia such as Alzheimer.

Solutions in built environment to prevent social isolation

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Keywords:
social isolation, built environment, common space, social innovation, space arrangement

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Built environment influences human behaviour, well-being and health in the long-term interaction. Space arrangement, furnishing and program of space can help to prevent or to diminish behaviour and phenomena in society with negative impact on public health, including social exclusion and isolation, one of the most crucial problem of the elderly.

Older adults had in the past stable and respected role in the family, living in bigger multigenerational families, neighbourhoods and communities, based on unity, solidarity and belonging – related to traditional socio-cultural values. By increasing individualism, modern nomadism of productive population and by practicing self- optimization and hedonism in societies with advances economies, traditional family systems are endangered.

In the modern societies it is hard to get back to the full traditional understanding of multigenerational housing, but it is possible to create housing concepts for co-living of more generations – by conscious social and material environmental design that encourages a different range of behaviour leading to socialization, combined with sufficient privacy, very much depending on social and political system, cultural differences and personal economic situation. Social and physical inclusion like the prevention of social exclusion and loneliness can lead to the reduction of health problems that often have mental /psychosomatic background.

Figure 1: Mixed program for public building-kindergarten and day care for the elderly - St. Vincent in Seattle.

It can be directly or indirectly supported by built environment. On macro-environment solution it can be found in providing diversity of multipurpose buildings with mixed programmes that are getting together people of different age and occupation and multigenerational housing concepts as well, where switching between being at home and at attractive and assessable public space in a flexible way is possible, and ration of privacy and socialization through natural meetings and gathering is adaptable.

On microscale sociopetal space arrangement – supporting socialization and communication, with possibilities of getting together can have positive impact on inclusion. To share and su-

pport each other on everyday basis in common shared spaces that are easily available. Exchange of knowledge, insights, energy flow between older adults and children/youth is a contribution for both sides. Creating and providing attractive and accessible common shared housing and public and semipublic space around housing or day care units. Without fences or other visual and physical barriers. By contemporary trend of supporting concepts of joined smaller housing units with possibility to have home day care, it is crucial to have not only shared space to meet and socialize naturally by passing through and getting to some point of everyday use, but also private room with size that accommodates also visitors where intimacy is a must but in the same time it supports socialization and communication, including meeting family that can feel comfortable and welcome during their visit. An important issue is to have good access to sanitary equipment- safe and welcoming shower, to feel clean and to have self-confidence by socializing.

The space concepts are more successful in prevention of social isolation if they are supported by appropriate programmes – based on neighbourhood community, professional day care and social workers and volunteers, e.g. programme of getting seniors out for a ride on special bikes adapted for pushing a wheel chairs in Bratislava in Slovakia etc. The most important issue here is the adaptability – flexibility in housing concepts is needed thus the society and life stories of its members are in steady change. At the same time it is also necessary to count with obstacles like stereotypes and fear from change.

Figure 1: "Stacionár" - Day care centre directly in the facilities of grammar school enables contact with children in the village Hrušov in south-central Slovakia, where seniors spend their day time with handworks and crafts, producing different small products also for sale.

Social isolation can arise not only by staying at home, but also in the institutional care, while the closer and fruitful inter-human relationships are possible rather in smaller groups.

According to the environmental psychologist Robert Gifford (1996), place attachment represents a deep experience of feeling part of a place. It is related to the richness of meaning and sense that is developed out of acquaintance with a place and, subsequently, when the place gets to be more familiar. This attachment can be to our homes, properties, communities or local nature sceneries and settings. Where the attachment ri-

ses, the intensity and meaning of the place and the meaning of Self become affiliated. Then the meaning of the place can become so strong that self-identity starts to be restricted by the place. On a smaller scale, many people are identified with their neighbourhood, quarter, village, farms, house and rooms and being separated from this bound can lead to social exclusion. At the same time coming into a new social group can be a challenge and stimulation for further personal development.

To demonstrate these ideas, the paper presents studies from the field of social architecture and design. Many organizations dealing with this kind of projects are gathered in institution DESIS network - Design for social innovation and sustainability that provides platform of social innovation projects in architecture and design. There are presented projects and shared experiences of authors and coordinators. One interesting project CULBURB- Cultural acupuncture treatment for suburb and also projects presented at Biennale of Architecture in Venice in 2018.This kind of approach is significantly supported also by study programs of design and architecture schools such as at the Institute without boundaries. Rural studio, School of Visual Arts, New York and their MFA Design for Social Innovation, where available experience-based programs are dealing with social design in praxis.

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Smart furniture definition based on key technologies specification in context of literature and patent analysis

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Smart Furniture is a very used term recently, which is related to current trends such as digitization, smart city or internet of things. Within these phenomena, Smart Furniture is used in different contexts, and so its concept is not clarified. The aim of the article is to show the context of Smart Furniture definition based on the key technologies related to up to date literature and patent analysis. The definition of Smart Furniture is based on previous research (Krejcar et al. 2019) which was undertaken based on searching in scientific and patent databases. Thus, the term is defined by its technical properties and parameters. Authors (Krejcar et al. 2019) resulted with definitions of "Smart Furniture" based on deep analysis of selected articles and patent activity: "*Smart Furniture is designed, networked furniture that is equipped with an intelligent system or controller operated with the user's data and energy sources. Smart Furniture is able to communicate and anticipate the user's needs using a plurality of sensors and actuators inside the user's environment, resulting in a form of user-adapted furniture or an environment that satisfies the user-declared needs and non-declared needs for the purpose of improving their quality of life in a smart world.*" (Krejcar et al 2019)

This definition is put into the context of actual trends of articles and patents content with selected future trends. Following article will deal with currents trends in literature and patents, which can be seen with the help of new analytical SW solutions.

Smart City and Smart Home are now the current trends in the research, industry and also market, with connection to fast growing Industry 4.0 and IoT trends. Since these Smart City, Smart Home and other components are already well established and defined, Smart Furniture is not such clearly described and defined as it is multi scope topic which covering furniture industry, design trends, and electronics and ICT on the other hand (Fig. 1 Left).

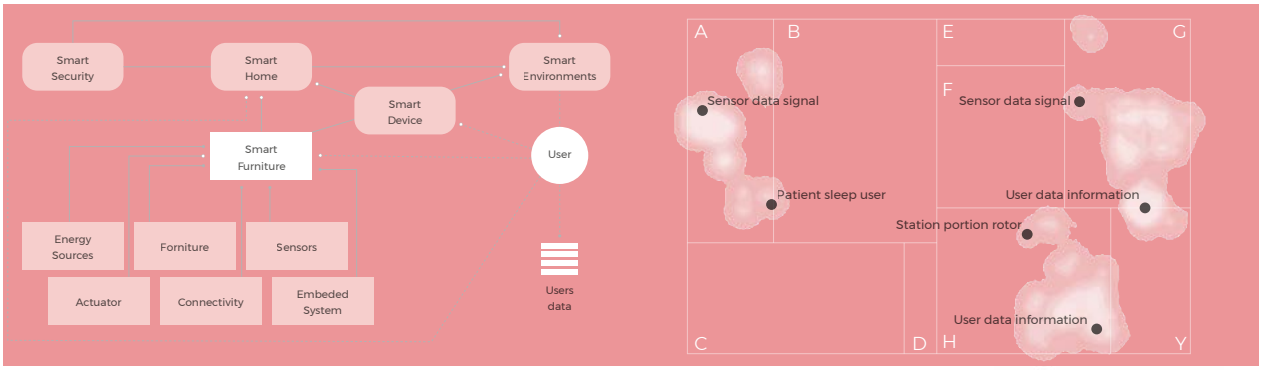

Figure 1: Left: Smart Furniture as a component of Smart City umbrella (modified from Krejcar et al 2019). Right - Code Map (CPC) for patent pool of "Smart Furniture" phrase in Title, Abstract, Claims, and Description.

Methods: A literature search was undertaken between 20 August 2019 and 04 September 2019, while the Web of Science database was included, which was searched by keywords that included the phrase "Smart Furniture". Patent searching was performed in the PatentInspiration database. In total 45 articles from scientific database and 146 patent applications were examined against strict criteria containing meaningful definitions of Smart Furniture.

Based on the analysis of key technologies and properties, clustering of results and their further analysis, it was found that the concept of smart furniture is specific to the following components: intelligent system, controller operated with user's data and energy sources, sensors and actuators.

Analysis is based on the all years searching for strict phrase "Smart Furniture" in TOPIC, which cove Title, Abstract and Keywords in ISI WOK database and Title, Abstract, Claims and Description in PatentInspiration database. Records from ISI WOK are available between years 2010 and 2019 in total of 45 records. Patents search in patentsInspiration with exact phrase "Smart Furniture" in Title, Abstract, Claims or Description. The result is 146 patents application from year 2002 (Fig. 3). 141 records is available with abstract, while 61 od all is granted.

Literature search can be analyzed using clustering, where we are using VOS Viewer SW solution, which provide visually indicative clusters. Another possible view is based on keywords analysis and parameters, which is common for both articles and patents. Patens activity can be further analyzed using special codes (IPC and CPC) which indicate area of technology used inside patents text, description or covered by patents claims.

Patent analysis: One of the most important information in filled patent application is CPC (Cooperative Patent Classification) Code, which is assigned by patent authority after initial screening. The CPC scheme is accompanied by a set of CPC Definitions, which are documents, which explain how to use the CPC scheme for classifying and searching a specific technology. These CPC codes provide relevant information, where is the target area of patent applications in the patent pool (result of patent search) – in our case for 146 patent applications.

CPC Code map show a graphical of similarity between patents and codes since the human mind is used to and can readily understand the use of maps to correlate distance between two items. This analysis indicates which CPC codes are used in our patent pool (Fig. 1 Right). The most used CPC codes in our pool are represented by CPC Codes also varies in time, where for last 4 years the most patented topics covers Speech recognition (G10L15/00), followed by Input arrangements for transferring data (G06F3/00) and Information retrieval (G06F16/00).

Based on the pool analysis, one of the most important result can be seen at evolutionary potential analysis, where properties has been extracted and described the most relevant in the

patent text and also which properties have not yet been explored. This is possible because every property is backed up with a list of synonyms (Fig. 2 Left).

Figure 2: Left - Evolutionary Potential analysis for patent pool of "Smart Furniture" phrase in Title, Abstract, Claims, and Description for all years (2002-2019). Right - Cluster analysis for publication records of "Smart Furniture" phrase in Title, Abstract and Keywords for all years (2010-2019).

ISI Web of Science: Results from database search provide 45 records from authors covering affiliations from countries like USA (7x), Japan (6x), Germany (5x), Greece and Romania (4x), Czech Republic, Italy and Lithuania (3x). There records are mostly in Computer Science and Electrical engineering.

Analysis in figure (Fig. 2 Right) provide a result from cluster analysis based on 45 ISI WOK records with keywords. There is a strong connection from Smart Furniture and Smart Citi and Smart Home topics. Next very intensive connection is for Market Research and Furniture Industry. From analysis is also evident that it is well surrounded by ICT technologies like: IoT, Bluetooth, Capacitive Proximity Sensors and Interactive Tabletops. Articles are also well connected to environments like Active Assisted Living, Adaptive Environments.

Discussion and Conclusion: Based on the specification of key technologies, clustering of results and their further analysis, it was found that the concept of Smart Furniture is specific to the following components: intelligent system, controller operated with user's data and energy sources, sensors and actuators. Also the current trends and technologies are showed as well as areas where the space for innovation is available.

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A short history of IoT architectures through real AAL Cases

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AAL, AmI, IoT architectures, WSNs, eHealth

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Summary: Advanced economies will have to deal with the assistance needs of their growing aging population, and technological solutions such as IoT (Internet of Things) for AAL (Active and Assisted Living) can address this challenge efficiently. This paper presents a history of IoT architectures in AAL applications through the lens of CETEM's real experiences in selected R&D projects, which evolved in parallel to technological solutions and approaches. Manufacturing companies, customers' needs and end-users have been drivers in this process. The paper presents the different architectural approaches with its main pros and cons, hoping to serve as a reference for future designs.

1. Introduction

During the last decades ICTs (Information and Communication Technologies) have permeated most of our daily lives, becoming an integral part of our lifestyle, but the real benefits to our societies is sometimes questionable. Care of older adults is one of the areas that can clearly benefit from AAL technologies. On the other hand, our economies need to leverage the use of AAL technologies to address the exponential growth of healthcare costs that comes with our aging population.

"IoT" is a relatively new term that implies the interconnection via the Internet of any kind of objects, which need to have or integrate computing and communication capabilities. IoT has successfully been applied to AAL, and this paper provides a short description of the evolution of IoT projects carried out in CETEM´s history. It´s worth noting that the latest solutions are the best fit, and that some value may remain in older approaches.

2. WSNs with local server

Around a decade ago, the concept of WSNs (Wireless Sensor Networks) was everywhere. It was used in the project called "Smart Sensory Furniture" (SSF) (2011-2012), where traditional furniture was augmented by the integration of sensor nodes (aka motes), which included different sensors (Botia 2012), some modest computing and control capabilities, wireless communications (Zigbee) and, in some cases actuators (e.g. adjustable beds or lighting).

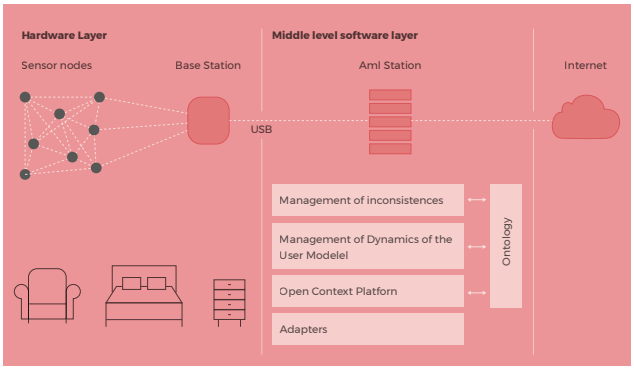

Figure 1: SSF architecture

The motes were arranged as a 2.4 GHz Zigbee mesh with a coordinator node, which was locally connected to the "AmI station", a small PC-based Linux machine. Data was analyzed auto-

matically by the AmI engine so as to find patterns of normal behavior. If current behavior differs significantly, anomalies or unusual situations were detected, and a remote server in some kind of call center was notified, where a person should take action. See (Bleda 2017) for more detailed information.

The previous approach required a dedicated network to be deployed, set up and maintained, and it implied an external service provider, similar to a call center. Therefore, the obvious evolution for a residence-like environment was developed in the "AmICare" project, which used the omnipresent WiFi, and a cheap Raspberry pi 3 (Bleda 2018). The nodes can be distributed anywhere with WiFi connection. Any device with a browser can connect to the server for information and notifications.

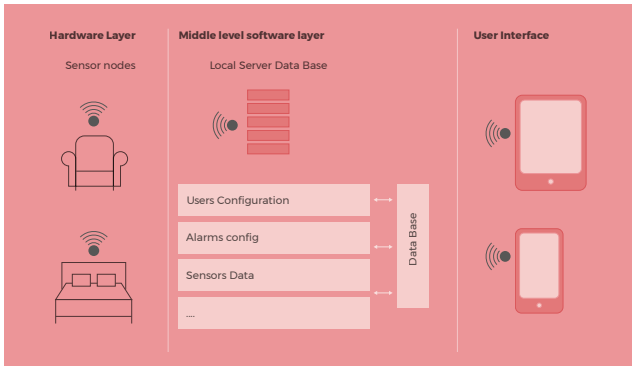

Figure 2: AmICare architecture

3. Single device system thanks to the cloud

SSF and AmICare approaches require to configure a local network and server. In the "Asistae" project (2016) we aimed at minimizing the complications at the end-user side by providing a single plug-and-play device that included an active GSM connection. First, the device connects to a cloud server. The user only needs to install a smartphone app and configure it with information and preferences. The complexity is moved to the hardware and cloud sides, and it can be updated to new requirements anytime. The architecture is made of three parts: integrated sensors, a mobile app and a cloud server. See for product info .

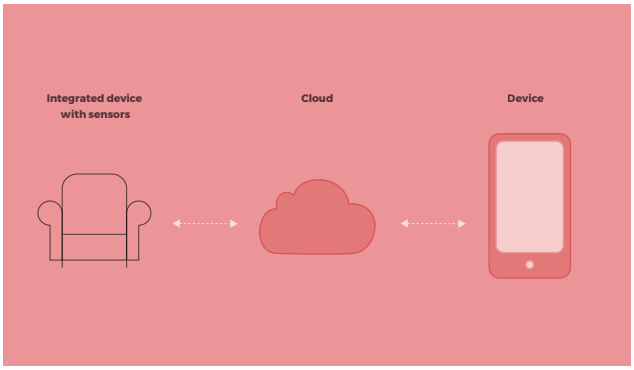

Figure 3: Device and cloud

Please, note that a hybrid architecture between section 2 and 3 can be obtained by moving the local servers of section 2 to the cloud.

4. Conclusions

This paper presents the evolution of key IoT projects carried out by CETEM during the current decade within the home habitat sector. The first example presented was designed for a scalable set of independent homes with a dedicated Zigbee network, whereas the other for a residence-like environment and using the existing WiFi. Then, a single device solution is described, ideal for making independent smart furniture pieces. Finally, a hybrid solution is proposed. This work could be quick reference of examples for guiding future designs.

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Resource Allocation using network Centrality in the AAL environment

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Content distribution in AAL, network centrality, social centrality

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As an ever increasing number of Internet users are becoming members of one or even many social networks, we are investigating how this social proximity can be used to benefit online applications and particularly Ambient Assisted Living Applications with their particular requirements.

The concept of social centrality was developed by researchers, who sought insight as to how social power is acquired within a group. The concept embodies the notion that the user being in the middle of user pairs, forms an indispensable part of the network.

The centrality measure is used to identify the most important node within a graph or network. The process of identifying an important node within a graph or network can have multiple applications including depending on how the term of importance is defined. In networks such as the Internet, it is also used to help identify key spreaders of content or key repositories of content. In more specialized networks such as Ambient Assisted Living (AAL) networks these key spreaders are even more profound. Additionally, these nodes can be used to identify key paths and routes for maintaining network connectivity under varying conditions. Centrality can used either as an indicator of importance or as a measure for the potential influence this node many have on its peers, the two differing in functionality.

The Ambient Assisted Living environment is viewed as an area where users often have one common characteristic, such as age and many belong to multiple social networks that are closely connected. As AAL applications are envisioned to carry important data for their users optimal and resilient placement is required.

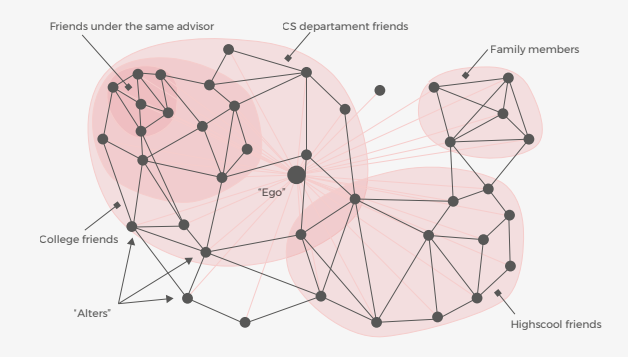
We are presenting here preliminary work on how we can improve data caching in multiple socially formed networks under the AAL environment, by using the concept of centrality, in order to improve data access speeds, availability and survivability.

Sosially aware resource allocation strategy

The concept of centrality comes from graph theory and translated to social networking it is used to identify nodes with certain importance within a social network. Different types of centrality have been identified over the years, all based on network and path metrics among network nodes. One of these definitions is that of betweenness centrality. Betweenness centrality is a measure of centrality in graph theory based on shortest paths and was as proposed by Linton Freeman in 1977 (Freeman 1977). In our work we extend this concept to parallel betweenness centrality

Influential Nodes Detection

Here we describe the implementation of parallel betweenness centrality in an Information Centric Network (ICN) where AAL applications and data are distributed. The aim is to reduce and localize the size of the network by parallelizing the running of the algorithm that identifies the influential bridge nodes. Fig 1.



An ego-network with labelled circles (McAuley and Leskovec 2012).

Our proposed algorithm, uses the parallel betweenness social centrality scheme for identifying the bridge nodes in the network. The proposed solution pseudocode is shown below. Here we specify a graph G(V, E) that represents the network topology. The nodes with the highest parallel betweenness centrality, are designated by the ParrallelBC function are denoted G_s^o, we then use the variable Ccurrent to hold the node selected to participate in the simulation.

Conclusions

Our results demonstrate that using social centrality caching schemes for data storage and especially Parallel Betweenness Centrality we can significantly reduce the distance of data to users. This will also provide a better experience to the end user since the closer the content to the requester the easier the access to this content becomes.

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Framework for the development of mobile AAL applications

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Introduction

Software development for Ambient Assisted Living applications has special requirements (Alkhomsan et al. 2017). Here we identify and propose the essential elements for the development of user centred AAL mobile applications, that not only comply with the basic usability requirements but are also so engineered that their use by the elderly is easy and enjoyable. Most software development tools are neutral to the age of their users especially those for the mobile apps environment where special limitations apply (Pal, Funolkul, Charoenkitkarn, Kanthamanon 2018), thus resulting is software that is difficult to use thus frustrating its users. In this part of our work we identify the major components that should be included in the development of AAL mobile application software.

Simplicity

The application must be very simple to use since the user is probably novice and inexperienced with technology.

Interface appearance

Colour and contrast are an important requirement to have in such an application where a large portion of users have issues with vision. Having no contrast may result in missing information in the user interface that the eye might not catch. The best practice for having a good interface is by having high contrast between the components of every page.

Like colours and contrast, the fonts are also required for this system. The fonts additionally aid and help on how good and easy the design looks and it can make or break an application's interface based on the first look or impression the users get.

Regarding the size of the text, since the elderly may have visual impairments such as glaucoma or presbyopia or might wear glasses it should fluctuate in higher size level. .

Now regarding the buttons, since they are very important for the functionality and the overall way the interface looks. We need to take into account in the button size too in correlation to the state of the user's vision. .

As for spacing, it is also required like the size of buttons and text to aid to the easiness of readability factor of the application. Something that looks good, is spaced in such a way that is easy to look at and is efficient to use with the minimum effort.

Interaction

Interaction is important to any system but especially to an application targeting the elderly. As the elderly don't have a good or enough knowledge or all things technology or using an application for that matter, giving back feedback is a key. It is important in order to give answers to frequent questions about the functionality of the project (Pal, Funilkul, Papastratorn, 2018).

Audio Feedback

As a different kind of feedback, an audio feedback can be helpful to user with visual impairments. Some of the best practices have audio feedback included by using a voice message for every action on the user interface and other have one voice message on every page explaining by hinting on what the user should do next and how to do a certain action.

Summary

In summary, the framework proposed for developing AAL mobile applications targeting the elderly population focuses on simplicity, reliability and ease of use. Elderly users, have specific requirements that should not be overlooked even though this might limit software functionality. But it is very important for the development of such an application to remember that simplicity is a key requirement and also that the users targeted may suffer from severe impairments and have little knowledge of technology. It is therefore very important that the basic principles of this framework are followed for successful results.

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Solutions for ageing well in the community

Sub-Working Group 4.2 Proceedings

Vice-Leader: Birgitta Langhammer (NO)

Second Sheld-on conference meeting
Proceedings Book

The use of Technology to promote activity and communication by the municipality services, examples from an urban area

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Background

The growing elderly population challenges the current organization of elderly care services and calls for new ways of delivering care work in a more cost-efficient manner (Directorate of Health 2013). The public health authorities stress that the amount of formal and institutionalized care services cannot maintain over time without compromising the welfare society. Thus, the elderly care arrangements must transform into more sustainable delivery of services involving to a larger degree work such as self-care and informal care. To accomplish this shift in elderly care work, the governments have developed several strategies including active aging, new types of housing supporting independent living, increased use of home-based care services and expanded use of assistive technologies.

To enable elderly people to live independently in their homes, the government aims to de-institutionalize elderly care services by upscaling home care services and care housing and downscaling long-term stays at nursing homes. Increasing use of assistive technologies will play a significant role in the ongoing transformation of care services, however our empirical data shows how difficult appropriation and use of technology are for elderly end-users.

Most elderly people want to live independently in their homes for as long as possible, and the majority of elderly people (74%) are actually doing so by the support they get from their family, see Figure 1. Over the two last decades, housing-oriented care such as assistive housing has become an international trend (Daatland and Otnes 2014) but is still viewed as controversial in Norway. Assistive housing includes nursing homes and care homes, whereas the governments' aim is to upscale care homes, downscale long-term stays in nursing homes, and to develop more extensive and robust home care services to provide increased home-based services (Daatland and Otnes 2014).

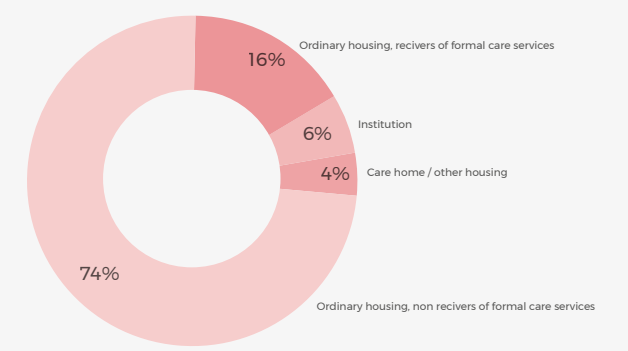

Figure: 1. Housing arrangement for ederly norwegians as from 67 years of age (statistic norway 2013)

The increased use of technology-supported care also plays a significant role in the transforma-

tion of elderly care services. However, in Norway, the use of assistive technology has been relative limited in scale and has been mostly concerned the use of a personal safety alarm.

The notion of assistive technology, which in Norway is termed "welfare technology", is an umbrella term for user-oriented technologies aiming to provide or assist users with public or private welfare services. Welfare technology is defined in a wide sense as technologies that supports the citizen to participate in the society. These services can be technical support of the users' safety and security, daily life activities, self-reliance, and participation in activities (Ministry of Education and Research 2011, 2013).

Welfare technology is divided into four main categories of technology support:

1. safety and security, e.g., the safety alarm service,
2. compensation and wellness, e.g., memory support, walker, light/heating control,
3. social contact, e.g., video communication, and
4. care and treatment, e.g., blood glucose meter, blood pressure monitor

We find it useful to distinguish between active and passive use of technologies, pointing to the fact that technologies can be designed with various levels of automation in order to support a diversity of users with different functional disabilities ranging from minor to severe disabilities (see e.g., Ministry of Education and Research 2013). We argue elsewhere that also fully automated technology can give users full autonomy, and there is no one-to-one relationship between the level of automation and the user's autonomy (Woll and Bratteteig 2018).

Conscious and active use of technology refers to situations when a person interacts with technology for a purpose, like doing a blood glucose check or pushing the personal safety alarm button when in need for assistance. This requires that the user is familiar with the technology's function and knows how to perform the necessary steps and accurately operate it. Active use is different from passive use of technology, where the technology does not require any conscious input by the user, e.g., an alarm is triggered automatically when preset conditions are met. For example, a fall sensor can alert people for assistance on behalf of the user when detecting a user on the floor. In such cases the user interacts with the technology without being aware of its interaction mechanism. Other examples of passive use of technology include shower nozzles / water faucets that provide constant temperature in the bathing / shower water, infrared water tap flow control, or automatic refrigerator door closer to mention a few (Mao et al. 2015).

Passive use of technology is particularly interesting for users who cannot be expected to understand abstract or symbolic representations (Woll and Bratteteig 2018). For example, nursing homes with old residents ("the oldest old") often have a high prevalence of dementia, suggesting a higher level of automation and passive use for the technology to support the users. Passive use of technology is not merely for residents in nursing homes. Most elderly people suffering from dementia live in private homes or care housing. Thus, implementation of various sensor technologies can support them by increasing their safety and security with respect to preventing fire, preventing or alerting falls, or alerting if they wander outdoors during night.

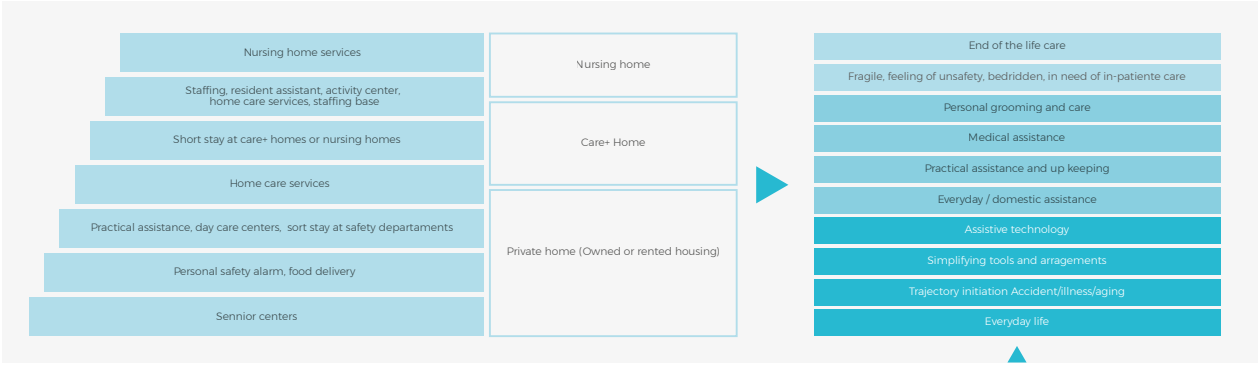

Figure 2: An illustration of the care staircase compared to our technology-supported elderly care trajectory. The blue gradient color in the trajectory illustrates the amount of technology use.

Figure 3 (below) illustrates how technology can enhance the self-care, informal care and formal care so that the time within each phase is potentially prolonged for the elderly persons traversing the trajectory. The level of support can be designed as layers of alternative solutions for a specific service, which then better can match altering user needs and fit a person's capacities and general condition. One example is the daily activity of shopping groceries, which is in the pre-trajectory phase (this example could also be illustrated in the care housing phase). Many elderly people with mobility or balance disorders use a walker for support when walking and going shopping. Several walkers are equipped with a basket for storage, e.g., to carry home groceries. If an elderly person does not master to physically go to the shop, s/he can shop groceries online and get the groceries delivered on the door. Moreover, if shopping groceries online is found difficult or impossible because of poor general condition, the person can get support from volunteer helpers or family members. In Figure 7, we illustrate some examples of layers of services connected to the housing situation of an elderly

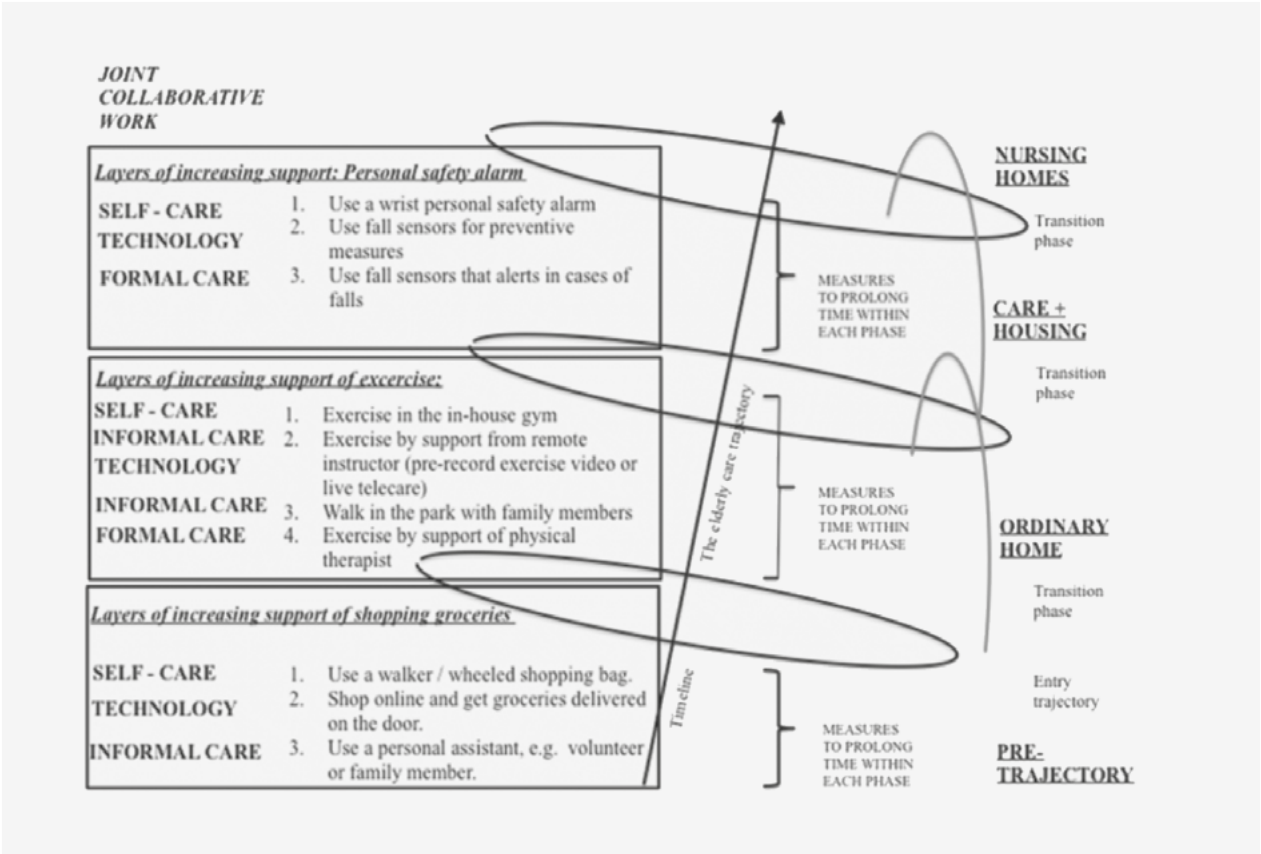

Figure 3: The figure illustrates layers of increased support for self-care, i nformal care and formal care work within distinct phases of the trajectory.

A challenge with the approach presented in Figure 7 is to find solutions that fit individual needs. First and foremost, the services need to match a user's actual needs and capacities. There is not one universal solution that fits all users. The formal care workers need to evaluate each user according to their actual needs. Types of interventions should be discussed and agreed upon in collaboration with the formal care workers e.g., home care nurses as they have the responsibility for formal services included in the trajectory. Thus, even if formal care workers delegate work responsibility to the self-care worker or informal care worker it is still the formal care worker, who has the main responsibility (and needs to be the back-up worker).

We argue that there is a need for several types of technologies for the same service in order to find a solution that fits a user's preferences. For example, a specific design of a digital medicine dispenser is not necessarily intuitive for all users, so distinct types need to be introduced if one type is found hard to learn.

The technology-supported services for critical services such as camera and sensors for digital supervision must work 24/7. If they do not work as planned or fail to alert when critical incidences take place, the users health and well-being can be at risk. This require self-testing solutions that alerts in cases when equipment is not online. This also calls for a technical staff supporting care workers to maintain equipment and make sure that the technology-supported services are robust.

In this presentation we will show and discuss examples from two municipalities in Norway how welfare technology and other strategies in the local surrounding are introduced to meet these challenges.

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Thermal environment assessment and adaptative model analysis in elderly centers in the Atlantic climate

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Elderly, thermal comfort, elderly centers, adaptative model, atlantic climate

cost EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

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This study is focused on assessing occupant' thermal comfort (TC) in 8 elderly centers located in the Metropolitan Area of Porto, a representative zone of the Atlantic Climate in Portugal. The determination of TC parameters involves (i) design of spaces; (ii) well-being of users; and (iii) energy efficiency of building facilities (heating and cooling systems). The development of TC models is preferably required in order to predict the thermal physiology and comfort of this susceptible population. The measurement campaign takes place from February to December 2019, and data collection is conducted 3 times per season in each participant institution, allowing a year-round analysis. For the purposes of this study, the indoor thermal environmental parameters (air temperature, air velocity, relative humidity and mean radiant temperature), the outdoor conditions (temperature and relative humidity), as well as, the physical activity (met) and clothing level (cl), are being analyzed in 22 living and activity rooms of the selected elderly centers. This allows to calculate PMV (Predicted Mean Vote) and PPD (Predicted Percentage Dissatisfied) indices and subsequently, evaluate TC. Moreover, a detailed building characterization has been performed by a walk-through survey including information such as type of building construction (concrete, masonry); thermal isolation of the building envelope (type of windows and doors, the presence of weather stripping); ventilation system (natural, mechanical, hybrid) and practices (opened windows and doors); types of indoor materials; use of heating appliances; evidence of dampness or mold; (opened windows and doors); etc.

The thermal sensation is also being estimated by interviewing the residents during each TC data collection, determining thermal sensation votes (TSV) as well as preference and acceptability levels through the ASHRAE scales. By now there are 160 questionnaires answered, expecting to reach up to 600 questionnaires total by December. This ongoing study is now on summer season monitoring, having already collected the spring and winter seasons data, both for the TC assessment and TSV survey. By way of example, preliminary PMV and PPD results of winter and spring season are shown in Table 1. Considering the recommended range of PMV values for optimum thermal comfort (between -0.2 and +0.2), it is verified that P07 is the only to present the PMV value (winter season) in accordance with this range of values. The upcoming data analysis will consider the application of environmental comfort models considering a longitudinal multi-criteria analysis (as seen in Fig. 1). This approach of adaptative TC models for older people also offers the possibility of improving the resident's life quality and saving buildings energy at the same time.

	Winter Season		Spring Season	
Institutions (code)	PMV	PPD [%]	PMV	PPD [%]
P01	-	-	0,23	11,0
P02	-0,44	9,68	0,13	6,5
P03	0,63	13,66	0,62	15,8
P04	0,49	11,46	0,63	15,1
P05	0,25	8,25	0,45	14,0
P06	-0,79	10,34	0,44	11,2
P07	0,05	8,47	0,51	11,9
P08	-	-	0,43	11,2

Table 1: Average preliminary results per institution of PMV and PPD indices

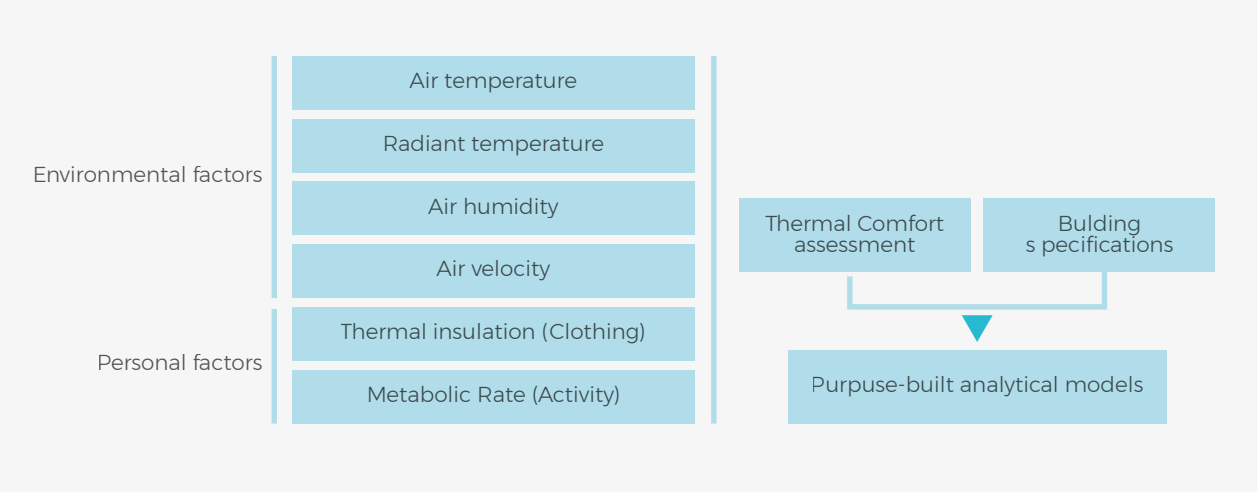

Figure 2: An illustration of the care staircase compared to our technology-supported elderly care trajectory. The blue gradient color in the trajectory illustrates the amount of technology use.

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Climate change in the city and the elderlies

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As the urban population increases and ages, issues related to climate change are tangible. Climate change summed to urban heat island affects cities climatic patterns, with the manifestation of extreme and more frequent weather events, including heatwaves. Climate change in dense cities place stress on everyone, but disproportionately on the vulnerable populations, including the old and those with chronic illness. Older people are the most at risk because of decreased mobility, changes in physiology, and their limited adaptive capacity. The short paper presents a discursive overview of both the issues and the possible tools to foster urban design strategies that cope with these.

In the near future, climate change will have an even greater impact in urban environments, leading to environmental stresses on urban infrastructure, especially if the business is continued as usual. This condition is exacerbated in urban areas where spaces are warmer than surrounding rural areas. The densification of cities and the use of artificial materials has indeed led to higher temperatures. Concrete, asphalt and steel reduce the city albedo (the thermal reflectivity of surfaces), and the absorbed heat is retained in place by thermal mass. The subsequent installation of indoor air conditioning systems increases the overall urban temperature (heat is extracted by indoor spaces and emitted in the street). These adverse circular effects determine the so-called Urban Heat Island (UHI).

The effects of UHI and high temperature in cites are variable, depending on pre-exposure health status, psychological well-being, and social characteristics. The oldest old are more likely to suffer negative health effects from climate change because of physical decline or frailty. Those individuals who suffer from multiple pre-existing chronic conditions and those who take medications that increase susceptibility to heat are more at risk because of those factors. Underlying chronic medical conditions (for example, cardiovascular disease, obesity) exacerbate susceptibility, as do medications that affect the body's thermoregulatory capacity. In sum, research on heat waves suggests that interventions to mitigate climate change, the urban heat island should be beneficial to elderly. As such, both tools and countermeasures to UHI effects have to be sought and implemented as soon as possible.

It is known that design choices, such as the form and the materials of buildings and open spaces, alter local thermodynamic phenomena, which in turn influence outdoor thermal comfort. The outdoor thermal comfort, as opposed to the indoor one, is ever-changing, with wide spatial and temporal variability due to weather changes. A set of strategies that modify outdoor thermal comfort and improve the thermal environmental quality of cities are today

available. Outdoor comfort can be either digitally modelled or measured on-site. In the last decade, the scientific community has become increasingly interested in the topic, encoding a few modelling tools to support its simulation. Outdoor comfort simulation tools and their capabilities have been assessed in previous research by the author, revealing that ENVI-met, CitySim and Ladybug Tools are software tools of interest to designers to define strategies to mitigate UHI. But when designers are working on the modelling of the outdoor thermal comfort of a specific location, it is essential to understand how elderly, are currently experiencing it. The understanding of human physiological adaptation to the environment could be modelled, but providing onsite information via local measurements, wearable sensors and comfort surveys is a piece of valid information.

Among the full range of design solutions for mitigating heatwaves and UHI, re-greening is the most viable. The increasing reduction of green areas in the city has massively decreased the environmental quality of cities. This discourages elderly from spending time outside. Greening of cities is a key strategy from many sides. It improves elderly psychological wellbeing; it positively influences air quality via CO2 mitigation and increases outdoor thermo-hygrometric comfort. Besides, greenery is the only known side-effect-free solution against heat in cities. These include not only the direct contribution to climate action but also a significant impact on halting biodiversity loss, through increased urban biodiversity, and an increase in healthy living conditions in cities, through the additional binding of air and water pollutants. According to UN SDG #3, nursing healthy lives and promoting well-being for all is central to building prosperous social, from a broader perspective. Debating urban green scape links these topics in a section that focuses on the potential of natural elements. Improving elderly access to green spaces and water is thus important for the "urban agenda".

To conclude, the evidence that climate change will potentially adversely affect older people living in cities is compelling. If the rapidly increasing older population worldwide is to be protected from the effects of climate change to the highest degree, this will be possible via urban planning modelling, local and human biometrics recording and via science-based solutions, including cities' re-greening.

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Loneliness is not simply being alone. How understand the loneliness in ageing to create smart environments

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Loneliness is a widespread concern among older people, especially in societies that are ageing exponentially. In this sense, loneliness is defined as the "unpleasant state experienced when there is a discrepancy between the interpersonal relationships one wishes to have and those one perceives one actually has". However, loneliness is not only an unpleasant state that has direct social consequences on the person, but also has negative psychological and physical impact. Although, until now, loneliness has been mostly studied homogeneously as a one-dimensional construct, Weiss (1973) proposes a model in which this variable has two dimensions; social and emotional. It is specifically the emotional dimension of loneliness, which acts as a harmful and "toxic" component for health, and which has an impact on the increased risk of mortality (O'Súilleabháin, Gallagher & Steptoe, 2019). In this vein, it is important to understand the impact of this socio-emotional variable on the physiological bases (e.g. immune system, endocrine system) and neural correlates (e.g. central nervous system; Nakagawa, 2015) that can determine the quality of life and life expectancy of older people.

Loneliness also has a cross-cultural component. In this way, each society has group characteristics that determine that loneliness is conceptualized at group level in a specific way within the same culture. Particurlarly, the feeling of loneliness is perceived as less harmful in individualistic societies (e.g. the United States) than in collectivist societies (e.g. Spain), although it is less common to be alone in the latter (Lykes, & Kemmelmeier, 2014).

Understanding the differentiating characteristics of loneliness at both the individual and cultural levels can serve as an axis to contribute to the improvement of the living conditions of older people, not only to intervene on a social level or on their physical and mental health but also to develop products and services that adapt to the individual configured within their own culture (for example, the segmentation of international markets taking into account the theoretical framework proposed by Hofstede; Soares, Farhangmehr, Shoham, 2007; Hofstede, 1984).

That is why loneliness constitutes a factor continuously ignored, but of vital importance and that must be taken into account in the ageing process. **Ageing lab** works to address the challenge of

loneliness in a holistic manner and taking into account its multidimensional character through various actions guided from a **Model** that preserves the **Dignified and Positive Ageing** (PDA Model; Rodríguez González, & Cruz, Lendínez, 2016). These actions include, for example; An

Intergenerational Center, projects that aim to address social Isolation in ageing through the application of technology (Pharaon) or digital training (E-inclusion).

Specifically, the creation of an Intergenerational Center makes it possible to work with different generations (children and older adults), addressing the complementary needs of both and fostering positive and affective relationships among all ages, as well as the transmission of knowledge, respect and social, emotional and cognitive development and in short; preventing social isolation. In addition, the **E-inclusion project** aims to provide digital training tools for older people in their own homes. To this end, home help assistants are trained in Digital technologies, so that, in their daily and direct intervention with older adults, they can play the role of digital trainer with them, thus promoting both direct and online relationships. On the other hand, the **Pharaon European Project** aims to integrate platforms with a multitude of technologies that aim to improve the quality of life and the needs of people in an ageing society. Specifically, through this project, Ageing lab as a partner aims to focus on the social field to respond the challenge of loneliness.

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From Co-design to Industry: investigating both ends of the scale of developing Social Robots

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Introduction

This paper merges two separate work packages – Co-design as a genuine bottom-up approach and industry-based perspectives on the development and future of social robotics. The first work package is mainly informed from undertaking a literature review of the premiere outlet for Co-design – the Participatory Design Conference series (bi-annual since 1990), where the focus was on Elderly and Social Robots. That particular work package is published in the [COST] state-of-the-art report as well as underpinned by own publications and research from a Danish neuro-centre context of co-designing social robots (Rodil, Rehm and Krummheuer, 2018).

The other, industrial, view has been informed by a Short Term Scientific Mission granted under the Sheld-on COST Action (16226) allowing a trip to visit Dr Isaacson at Faculty of Social Welfare & Health Sciences Department of Gerontology, Haifa University in Israel and a series of companies pertaining to development of social robots (and more broadly) for the ageing population. The STSM objectives (STSM, 2018).

The concept of Social Robots on a scale

Social Robots, defined according to the International Journal of Social Robotics, as "Social Robotics is the study of robots that can interact and communicate between themselves, with humans, and with the environment, within the social and cultural structure attached to its role." (IJSR, 2018)

There are many definitions like the one above and they all share the inability to accurately address, what makes a robot a social robot? In times that are very positive towards the multitude of challenges which can be remedied by artificial intelligence, robots etc. it became a somewhat strange experience to keep reading about the promised land of these social robots – both in academic outlets and in mass news outlets. As the definition (above) fails in capturing the most basic nature of social robots, we decided to investigate the concept and its plausible relation to the ageing population. We formulated an initial research question based on the assumption that the ageing population, due to shrinking personal networks and (in many cases) are less digitally literate than younger generations, must be primary adopters of sociality enabling autonomous creatures – social robots.

The idea of a scale came from considering how underlying technology development processes might or might not be the reason why there is little fruitful construction and uptake of technology. On one end we positioned perhaps the most academic and bottom-up process (Participatory Design/Co-design) and on the other end user-centred companies employing

novel technologies available – some of the companies where the expectations to see them succeed are highest. The question was, are any of those two ends representing technology, which has enabled the ageing population to be more social with the use of robots?

Findings

The investigation began by surveying 433 papers from the Participatory Design Conference series as Participatory Design (PD) represents a design methodology very much arguing for the inclusion of future users in design processes as a way to handle the technical barriers, make the systems more relevant on a small scale (contextual and situational) – all to ease adoption.

The first time robots are mentioned directly in the literature is in the proceedings of the PDC in 2002. In conclusion, the field of PD (limited by the PDC proceedings and search strategy) does not provide any technical endeavours cracking the code of making robots social for the ageing population. Robot solutions are primarily limited to ideation (very early project phases), and very little tangible robotic development is published. While the field of PD has fallen short in providing a way into a promising social robotic future, we decided to look at the other end – the industrial one. This industrial end shows optimism in the number of millions of dollars invested and where there is a liberal, almost deterministic view on technology.

It should be mentioned that the company visits in Israel were located at some of the companies which the rest of the world expects a lot from.

To summarise the insights gained during the STSM.

The visited companies in Israel are:

1. Not designing and developing with a participatory agenda. In general, the companies' approach can best be classified as user-centred.
2. Having significant challenges in identifying who will pay for their products. Products are too expensive for the ageing population (B to C) and not attractive enough for institutions (B to B).
3. Not yet able to entirely create functioning social robots and they are not social

The conclusion is, there are not yet social robots for the ageing population to adopt, nor are these systems just around the corner. Technologically they are not advanced enough or affordable, but most importantly, they do not seem to capture the essence of being social.

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Thermal comfort perception in elderly care centers. Case study of Lithuania

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Introduction

People spend indoors between 80 – 90 % of their time. It is important to ensure both good indoor air quality and thermal comfort indoors, especially to people who belong to vulnerable groups. Studies show, that in order to have comfortable indoor conditions which could satisfy aged people different thermohygrometric values are required, especially during winter season (Salata et al. 2018). Giamalaki and Kolokotsa (2019) presented study which shows, that there was a preference among the elderly for a warmer thermal environment in winter season compared to cooler in summer. The aim of this study is to investigate thermal comfort conditions in elderly care center locate in Kaunas, Lithuania.

Field measurements

Field measurements were performed in winter (February) and summer (August) period of 2019, in Panemunes Silas elderly care center (ECC) located in Kaunas, Lithuania. Temperature and relative humidity were measured in 15 naturally ventilated rooms (6 belong to an intensive care section). Temperature and relative humidity (RH) were measured with HOBO MX11011 data loggers (±0.2 ˚C, ±2% RH accuracy). The stand with instruments was placed in the middle of each room. The temperature and RH were measured in all tested rooms at 0.1, 0.6 and 1.1 m height. Parameters were recorded at 1 min. interval. Short term measurement method was used: equipment was placed in the rooms for 35 min. For the stabilization of indoor environment conditions 25 min. were dedicated, and 10 min. of data were analysed.

Results

In Fig. 1, the average indoor temperature and RH of winter and summer periods are presented.

Winter season results show that an average temperature in rooms was 20.36 ˚C and the average relative humidity was 37.38 %. In some rooms values were outside national reference norms (HN 125:2011), as temperature was 17.52˚C and relative humidity was lower than 24 %.

Summer season results show that an average temperature in rooms was 24.02˚C and the average relative humidity was 55.18 %.

Figure 1: Average temperature and relative humidity in the rooms at height of 1.1 meters

Conclusions

Some studies (Salata et al. 2018) show that even if the thermal comfort zone is achieved, (temperature between 20 ˚C and 24 ˚C) it might be not warm enough for elderly people as they would prefer temperature by 2 ˚C higher than neutral temperature.

Investigation in Panemunes Silas ECC shows, that in some cases thermal comfort would not be ensured for elderly people.

There is a need of further investigation of thermal comfort conditions in premises where elderly people spend most of their time.

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Human – machine interaction - Assessment of seniors' characteristics and its importance for predicting performance patterns

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Demographic trends in last decades indicate a marked rise in the number of elderly people in the population and there is a high correlation between age, mobility and disability. The share of elderly people in the total population is expected to rise from 21% in 2000 to 31% by the year 2020 and to around 34% by the year 2050. Disabled people represent around 13% of the nation. Various initiatives recognise the needs of elderly people. With changing attitudes and conditions the desire to travel for social life, business and leisure represents a potential major new source of ideas for travel providers, architects, urban planners, car, IVIS and ADAS designers and producers.

Due to demographic changes older and disabled people represent a significant and permanent growing part of Czech population. We lack progressive increase over the past decade in the social awareness of the requirements for older and disabled people throughout the Czech Republic and other parts of Europe. This progression should move from making provision for older and disabled people on a welfare-oriented basis, towards increasingly more understanding of elderly needs, equal access to all facilities as a matter of human rights. Improving access to any form of travel will provide additional social, as well as economic, benefits at personal, governmental and commercial levels. Faced with the challenges of an ageing European population, we would like to encourage innovative solutions that transform this challenge into an opportunity by responding to the needs of older Europeans and making active ageing a reality, keeping older people healthy, mobile, independent, socially engaged and fulfilled as valued contributors to society.

Senior drivers may constitute some danger because their limitations regarding some obstacles connected with age and deterioration of their senses. But new IT solutions may help; especially IVIS and ADAS solutions are very promising. But many questions regarding proper use are still not answered. We should use a procedure to recommend that helps to understand existing Human - Machine Interaction problems. Many needs become only transparent if appropriate methods are used. In the case of our projects, a combination of qualitative, quantitative and heuristic methods was chosen. Relevant questions were discussed and elaborated together with the target groups.

There is an increasing conviction among researchers that personal variables should be taken in higher consideration in the researchers studying effect of in-vehicle informational systems (IVIS) on safety. Senior drivers' characteristics and features are inadequately, or not systematically, evaluated in behavioural research, especially in performance studies, which may confound research results. In fact there is sufficient scientific evidence that driving is a result not only of maximum drivers' capabilities, but also of senior drivers' features, attitudes and motives determining how old drivers' use their cognitive-motor skills. It could be useful for the specific research to make use of a miscellaneous of different methodologies that take into account the complexity of drivers' behaviour. In particular the possibility to discriminate a priori between careful and risky drivers when evaluating certain behavioural patterns should be employ both in laboratory and real traffic experiments, to evaluate the impact and the

weight of those variables on the observed behaviour when IVIS is in use. To overcome those current difficulties, several levels of work were carried out: A review of existing psychological knowledge on personal features, attitudes and motives influential for driving has been confronted and integrated with the research run in VUT Brno on the development of a 'reference model' of typical behaviour that was used as a reference case in simulator trials or in real road observational studies. The input consists in the recognition of personal variables influencing performance as well as in the individuation of existing assessment tools that could be appropriate for research requirements on this topic.

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Potential biomarkers and risk factors associated with frailty syndrome in older adults – preliminary results from the BioFrail study

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One area of concern in the scientific community is the burden of environmentally induced disease in susceptible populations. Older adults are a well-recognized susceptible population due to the decline of immune defences and the burden of multiple chronic diseases. Frailty is a multidimensional geriatric syndrome characterised by increased vulnerability and functional decline that may be reversed if addressed early. Our goal was to explore possible biomarkers associated with frailty and risk factors (social, medical, occupational history).

A group of older adults (≥ 65 years old) was engaged in this study. Frailty status was assessed via Fried's frailty model, 47.5% as robust, 49.2% as pre-frail and 3.3% as frail. A significant higher prevalence of second-hand smokers was observed in the pre-frail group when compared to robust. Additionally, a higher prevalence of robust individuals consuming home-produced vegetables was found in comparison with pre-frail.

Comet assay was used to assess DNA damage in whole blood and H2AX assay for H2AX phosphorylation in lymphocytes. Blood samples were also used for the quantification of mercury levels. Key exposures were assessed through the application of a lifetime exposure questionnaire and the influence of nutritional status, cognitive function and functional status was evaluated by standardized scales. No significant differences were found between robust and pre-frails regarding the biological endpoints tested. Nevertheless, among the robust group the levels of H2AX phosphorylation were significantly increased in former smokers compared with never smokers. In addition, oxidative DNA damage were decreased in robust consuming home-produced vegetables. Regarding the pre-frail group: a higher prevalence of second-hand smokers was observed in this group compared to robust.

Preliminary results obtained in this study are of paramount importance to understand if the way we live(d) or worked can impact the way we age. Further investigation is necessary to explore the role of key exposures, its impact on health, to standardize biomarkers to be used in clinics, and to understand the influence of clinical parameters.

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Consciousness Society creation. Stage development

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This exploratory paper investigates Adaptability as the Engine to create Computer Software for the Consciousness Society. Adaptable Tools advance Software for Artificial Intelligences. The paper aims to open the discussion around the impact that Adaptable Software Tools might have on Information, Knowledge Based and Consciousness Societies i.e. Homo-Robotic Societies of Information Era.

Paper employs an exploratory literature review investigating the development of Consciousness Society and current state of the art in relation to Adaptability as Engine to create Software. They are transformed in a new Engine: the Robotic Adaptable Tools. It is discussed the Impact that Robotic Adaptable Tools might have on Consciousness Human-Robotic and Robotic-Human Societies.

Purpose: This exploratory paper investigates Adaptability as the Engine to create Computer Software for the Consciousness Society. Adaptable Tools advance Software for Artificial Intelligences. The paper aims to open the discussion around the impact that Adaptable Software Tools might have on Information, Knowledge Based and Consciousness Societies i.e. Homo-Robotic Societies of Information Era.

Design/methodology/approach: Paper employs an exploratory literature review investigating the development and current state of the art in relation to Adaptability as Engine to create Software for Computers, Systems, Networks, and Complexes of Intelligent machines in Information Era; this literature review serves as the starting point of subsequent theorizing.

Findings: Based on the literature review we theorize that the Adaptable Tools were used for creation Software for different Generations of Computers, Systems, Networks, and Complexes of Intelligent machines, last ones representing ROBO - intelligences with creativity, emotions, temperaments, and sentiments. In this process Adaptable Tools achieves new horizon of creation, they are transformed in a new Engine: the Robotic Adaptable Tools. To name just a few uses of Robotic Adaptable Tools, its can help in: (1) supporting definitions of new robotic intelligence entities, (2) its stratification, (3) its algorithmic representation, and therefore (4) improving robotic skills and competences as well as (5) generating requirements for new competences, and (6) promoting a collaborative environment among the Actors of Computing Industry.

Research limitations/implications: This paper opens the discussion around creation Software for Computers, Systems, Networks, and Complexes of machines using Adaptable Tools, as well as its succession in creation Artificial Intelligences with creative, emotional, temperamental and sensual possibilities using Robotic Adaptable Tools. Paper suggests a wide range of areas for further research in the branch of Robotic Industry.

Practical implications: In this paper we argue that by looking at Robotic Adaptable Tools as more than just a set of tools for improving robotic intelligences Adaptable Computing in Robotic Industry can address some pitfalls of a particular type of Homo-Robotic communication in Consciousness Society.

Originality/value/sustainability: The Adaptable Tools have been developed as part of Software Industry in Information Era. They have used in creating Computer Systems for different generations of computers. The Robotic Adaptable Tools are a new and very popular approach and is demonstrated that it is powerful in many areas of Artificial intelligences Industry. This paper is novel in that it initiates a dialogue around the impact that Robotic Adaptable Tools might have on Human-Robotic and Robotic-Human Societies.

JEL Classification: C88, L86, M00, O31, L20.

Attempts to improve the situation of elderly people in the Republic of Moldova

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Keywords:
robots, Intelligence, consciousness society, age-friendly digital world, human – robotic society

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Introduction

The human society has entered the period of immense studying of possibilities of psychological working together of people and robots in the future Human – Robotic Consciousness Society.

The research projects are proposed and the implementation of the population support activities in the Republic of Moldova in the context of the improvement of the life of youth people and rural intellectuals and, in particular, improving the living conditions of Women, girls and elders. Special attention is required to study of robots influence in the life of age.

The project "Solutions for migration in the rural sector of the Republic of Moldova" is concerned to anti-migration management in the Republic of Moldova. The project aims to decrease the number of labour migrants from Republic of Moldova by 40% by creating new working places and developing of abilities of working according to European and global standards.

The Project "Solutions for migration of intellectuals from rural sector of the Republic of Moldova" had to implement an twelve month activity by teaching about 80 intellectuals from rural sector of the Republic of Moldova how to write different kind of projects in order to atrack local, republic, and foreign investors and to rise rural sector in different areas.

The general objective of the project "**ENtrepreneurial and DIgital Skills from school to university – a solution for future economic development of North-East Romania and Republic of Moldova. Educational network around the RO-MD** border" is to support the economic development on both sides of the Romania-Republic of Moldova border, through building a joint network of educational institutions to pilot a program on entrepreneurial education and digital education.

The project "**Business plans for Women's rural SMEs**" will perform the business development training for women and girls on how to write SOFT Business plans for Women rural SMEs.

Main objective of the Project "**Rural SMEs for Network "Demand & Supply**" consists in training the population from Ungheni District's rural localities to prepare Dijital Business plans for rural SMEs

Proposition the Proposal: "**The creation of the European Network for the implementation and support of industry for elderly people**" contains Strategic goals and Spheres of activities for people in the age.

The proposed Proposal: "**Organization the international on-line conference "Creation Consciousness Society**" in March 2020 constitutes creation of the Network on collaboration of People and Robots on physical, intellectual and spiritual life in an Age-friendly Consciousness Society.

Conclusion

These propositions represent investigation of the anti-migration procedures in rural localities of the Republic of Moldova through the creation of the digital Business plans with special orientation. They propose the training activities with respect to youth, women and the elderly through the anti-migration procedures of population in the Republic of Moldova are proposed.

The proposition for COST Activities "**Creation the group of researches to work on International Interdisciplinary Network on Health and Wellbeing in an Age-friendly Digital World**" shall intensify research collaboration opportunities to people and robots on physical, intellectual and spiritual dimensions. Special attention is required to study of robots influence in the life of age.

Similarly, perspectives on the ageing life course and the role of the elderly within society have made the elderly more essential to maintaining the workforce and offer opportunities for older adults to remain economically active long after traditional retirement ages.

JEL Classification: C88, L86, M00, O31, L20.

Solutions for ageing well at work

Sub-Working Group 4.3 Proceedings

Vice-Leader: Petre Lameski (MK)

Second Sheld-on conference meeting
Proceedings Book

Quantitative analysis of publications on policies for ageing at work

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aging at work, policy, quantitative analysis

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Abstract. The concept of Ageing at work comes from the urgent requirement to help ageing workforce of the contemporary industries to maintain productivity, while achieving a work and private life balance. Current re-search activities on polices covering the concept of Ageing at work are lim-ited and conceptually different. This paper provides the quantitative analy-sis of publications on policies for Ageing at work. After search of databases (i.e., Pub-Med, IEEE Xplore, and Springer), a total of 1724 publications were selected. The quantitative analysis show that age based discrimination was the main motivation for research activities which were directed to the dis-cussion of legislation and national policy solutions, as well as intensifica-tion of collaboration at international level. These findings may serve as a starting point for future research activities intended to propose policy framework that describes the concept of Ageing at work.

Introduction

Demographical data suggest a rapid aging in the active workforce, as a result of the overall aging of the population. The concept of Ageing at work comes from the ur-gent requirement to help ageing workforce of the contemporary industries to maintain productivity, while achieving a work and private life balance. While there are many researches regarding aging population (i.e. over 65), current research activities on policies covering the concept of Ageing at work are limited and conceptually differ-ent.

The objective of this paper is to perform the quantitative analysis of publications on policies for ageing at work, which is intended to start the discussion and formula-tion of policy framework that describes the concept of Ageing at work. It targets gov-ernment decision-makers, the non-governmental sector, the private sector, and all of whom are responsible for the formulation of policies on Ageing at work.

Methodology

The quantitative analysis of publications on policies associated with the concept of Ageing at work is conducted. A publication search was undertaken in August 2019 in order to identify published peer-reviewed articles in English. The databases searched included PubMed, IEEE Xplore, and Springer (the first source from 2008 until the last in 2019). The keywords included the following phrases: "successful aging at work", "active aging at work", "healthy aging at work", "productive aging at work", "technology for active aging at work", "older adults

at work", "successful aging in gerontology and life span psychology". In addition, Motivation and Solution proper-ties groups were used for selection of the publications for the analysis.

Results

A total of 47.330 publications were identified through databases searching and 25.187 publications were screened. After 7756 screened publications were excluded from the further analysis, a total of 17.431 article abstracts were assessed for eligibility. Final-ly, a total of 1724 publications were selected for further qualitative analysis.

The most keywords were found in PubMed database (1094 articles), followed by Springer (584 articles), and IEEE Xplore (56 articles). The "older adults at work" is the most common keyword phrase found in 861 articles, followed by "successful aging at work" found in 261 articles, "active aging at work" found in 211 articles, "productive aging at work" found in 190 articles, "healthy aging at work" found in 175 articles, "technology for active aging at work" found in 23 articles, and "success-ful aging in gerontology and life span psychology" found in 3 articles. The most keywords (226) were contained in articles published in 2016.

The Solutions property group was more often analyzed compared to Motivation property group. The "age based discrimination" was the most frequently analyzed Motivation property, since it was mentioned in 775 articles. The "legislation" is the most prominent Solutions property that was contained in 585 selected articles. The highest co-occurrence (21) of both Motivation and Solutions properties in Springer publications was found in articles considering "national policy" and "sustainable growth" properties.

Conclusion

The "age based discrimination" was the main motivation for research activities which were directed to the discussion of "legislation" and "national policy" solutions and intensification of collaboration at international level. A conducted quantitative analy-sis serves as a basis for the qualitative analysis intended to propose policy framework, which provides a comprehensive approach for addressing the challenges related to the concept of Ageing at work and the development of specific actions at national and international levels. Therefore, a research agenda for future research is formulated: (1) conduct the qualitative analysis to propose the policy framework on Ageing at work, (2) conduct a meta-analysis on factors influencing the concept of Aging at work, (3) design a national-level and EU-level survey about the about the current policies asso-ciated with the concept of Ageing at work.

Can deep learning contribute to healthy aging at work?

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The increased aging population has introduced quite a few challenges for the developed and the developing countries. For the European Union it is estimated that by 2050 there will be a very large percent of older population and that the burden on the health insurance systems and the pension systems will be significantly increased. One of the ways to tackle this problem is to provide healthy environment for the aging population in their working premises which would increase their productivity and prolong their ability to provide income for themselves and the community.

Machine learning has contributed to elevating various areas of the human society and industrial development. In recent years deep learning as branch of machine learning has received increased interest due to the excellent state of the art results obtained with deep learning based approaches.

In this paper we review the development of deep learning research and applications that give contribution towards healthy aging at work. For this purpose, we do a quantitative analysis of the available publications in IEEE, PubMed and Springer. We perform an automated survey using the NLP toolkit presented in (Zdravevski et al. 2017). We review papers published from 2009 to 2019 that contain any of the phrases: "successful aging at work", "active aging at work", "healthy aging at work", "productive aging at work", "technology for active aging at work", "older adults at work", "successful aging in gerontology and life span psychology". Additionally, we filter out papers that contain phrases related to Artificial Intelligence and its subfields. The obtained results are depicted in Figure 1.

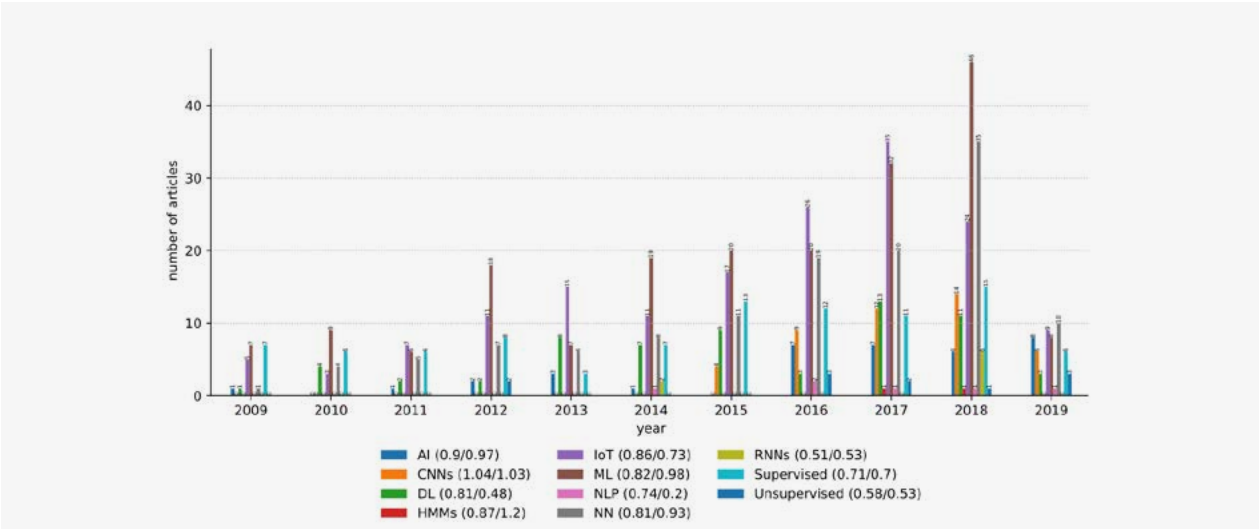

Figure 1:AI related topics trends

As it can be observed there is an increasing trend in publications and thus in scientific interest for applications for healthy aging at work and applications of machine learning and internet of things which is quite popular. Another observation can be made that deep learning related topics such as Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs) and the term deep learning itself are also trending and have almost linear increase in the number of publications. Without getting into the qualitative analysis of the papers one could conclude that deep learning topics are becoming more and more relevant in the healthy aging at work research areas and we can expect increased number of publications and applications in the following period.

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Work and social activity for longer healthy life

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Institutional attention for the ageing population began to appear in the last decade of the 20th century. On December 16, 1991 the United Nations General Assembly adopted Principles for Older Persons (Resolution 46/91). The outlined 18 principles are grouped under five themes: independence, participation, care, self-fulfilment and dignity. In the section on dignity there is a text against age discrimination: "Older persons should be treated fairly regardless of age, gender, racial or ethnic background, disability or other status, and be valued independently of their economic contribution" (United Nations, 1991).

The Madrid International Plan of Action on Ageing (MIPAA) and the Political Declaration, adopted by the Second World Assembly on Ageing in April 2002, are still among the global guiding documents that have a priority focus on the areas of the rights of older adults and their well-being in a supportive environment (United Nations, 2014).

According to the National Statistical Institute, Bulgaria ranks 7th in the proportion of senior citizens over 65 – 21 %. (1). The forecasts are that by 2060 life expectancy in the country for people after the age of 65 will roughly increase for men by 6.3 years and for women by 6.1 years. A very serious change is expected in the age dependency ratio (15-64), which is expressed as a percentage of the population aged 65 and over and the population aged 15-64. For 2060 its value is projected to reach 58, while currently it is 30 (National Statistical Institute, 2019).

Demographic imbalances, such as population decrease and ageing stronly impact the workforce developments. Thus they create problems for the macro-fiscal stability and sustainability of all social systems - the labor market, the retirement methods and pension plans, the healthcare arrangements, the social assistance and long-term care order, the education classification, etc.

The European Year 2012 covered three dimensions of active ageng:

- Active and longer working life of the elderly, including: encouraging elderly to stay in work which requires improving working conditions and adapting them to the health status and needs of older workers; updating their skills by providing better access to lifelong learning and reviewing tax and benefit systems for ensuring effective incentive to work longer.
- Participation of the elderly in social activities, which is understood as: improvement of opportunities and conditions for older people to contribute to the community through volunteering or as family assistants and their inclusion in society.

- Creating conditions for independent living by: promoting healthy lifestyles; preventing socially significant illnesses and creating a more conducive living environment for adults (public buildings, infrastructure, transport, residential buildings) that allows them to remain independent for as long as possible.

In order to achieve these goals, Bulgaria has developed two srategic important documents that outline the framework of its actions: The National Concept for Promoting the Active Life of the Elderly (2012-2013), which introduces a horizontal integrated approach and mainstreaming of ageing in all areas, sectors and policies, and The National Strategy for Active Life of the Elderly in Bulgaria (2019-2030), which develops a comprehensive cross-sectoral approach for active and productive elderly life in good health. The emphasis in both documents is not only on the population demographic balance (birth rate, mortality, migration), but also on policies and measures for the development of the quality of human resources with regard to improving the health, educational and general social status of people, as well as of upgrading the conditions and quality of their lives.

Bulgaria is the second country after Poland in the European Union, which has started work to introduce at national and regional level the Active Ageing Index (AAI), jointly developed in 2012 by the United Nations Economic Commission for Europe and the European Commission as a key monitoring tool for policy makers to enable them to devise evidence-informed strategies in dealing with the challenges of population ageing and its impacts on society. The results show so far that active longer working life and intense participation in social activities create conditions for independent living and longer healthy life of the elderly in the country.

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Reverse mentoring as an alternative strategy for lifelong learning in the workplace

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With advances in technology, many jobs are fading and new ones are emerging. Knowledge gained years ago can, in today's world, become quickly obsolete, so the ability to stay up-to-date is more important than ever. Due to the ageing population and increase in proportion of older workers, employers need to dedicate their attention not only to the development of the young and upcoming, but also to senior employees. However, cognitive changes such as slower processing make storing and retrieving information from long-term memory harder for older employees (Ford and Orel 2005), and they may benefit from a more individualised, slower-paced method of learning. A meta-analysis also found that older workers are less willing to participate in training and career development activities (Ng and Feldman 2012). Consequently, there is an increasing need to find alternative education strategies that are effective and suitable for older workers.

A popular option for knowledge sharing is a mentoring relationship, where a mentor, often an experienced senior professional, helps a mentee, typically a new junior employee, learn and develop their career with psychological support and role modelling (Chen 2013). In addition to developing explicit knowledge, mentorship can also enhance mentees' psychological capital, especially their self-efficacy (Luthans and Youssef 2004) and resilience (Istenič Starčič and Mikoš 2019). As learning through one-on-one interaction may be more appropriate for older workers than training, we consider an alternative way to promote knowledge transfer to seniors – reverse mentoring. The main functions remain largely the same as in traditional mentoring (Chen 2013), only it involves a younger employee acting as mentor and sharing expertise with an older colleague (Murphy 2012).

The first organization to formally implement the concept was General Electric Corporation in 1999, where 500 upper-level managers were paired with technologically-savvier younger employees who successfully tutored them in using the internet (Murphy 2012). Reverse mentoring can be useful for senior workers not only to learn about current trends and obtain new technical knowledge and skills (e.g., technological improvements, use of social media), but also to gain valuable generational insights from direct social interactions (Harvey et al. 2009). However, even if the main idea behind reverse mentoring is building competencies for the older workers' future careers, the program is also beneficial to the mentors, who develop leadership and communication skills and business knowledge, and the organization, who, by using an innovative and cost-effective strategy, encourages relationship development and promotes organizational learning, cooperation, and the dismantling of age-related stereotypes (Murphy 2012).

As with any other (mentoring) relationship, there may be challenges that can hinder its success. In planning the mentoring program, organizations must define its objectives, address the potential lack of time, and consider individual differences in personality, values, and participants' willingness to make mistakes and look past their seniority and authority (Murphy 2012).

Empirical research on reverse mentoring is still in its infancy, but results look promising and its potential benefits are making the model increasingly popular. As older workers are intrinsically motivated to further develop their digital skills (Kaše et al. 2019), reverse mentoring seems like an attractive option to encourage the lifelong learning of those employees who may be hesitant to participate in training programs.

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What users want – research on workers, employers and caregivers demands on SmartWork AI system

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Introduction

SmartWork, 'Smart Age-Friendly Living and Working Environment', is a European project addressing a key challenge facing today's older generation, as they are living and working longer than their predecessors: the design and realisation of age-friendly living and working spaces. The SmartWork system will be comprised of a suite of smart services to support office workers aged 55+, delivering benefits for the workers, their employers and carers. The system will use Artificial Intelligence (AI) to unobtrusively and pervasively monitor workers' health, behaviour, cognitive and emotional status. Through work ability modelling, it will respond to their needs by, e.g., identifying personalised training support for the employee to learn new skills, suggesting flexible working practices to maintain a work/life balance, while the monitoring data will enable the employee to self-manage chronic health conditions.

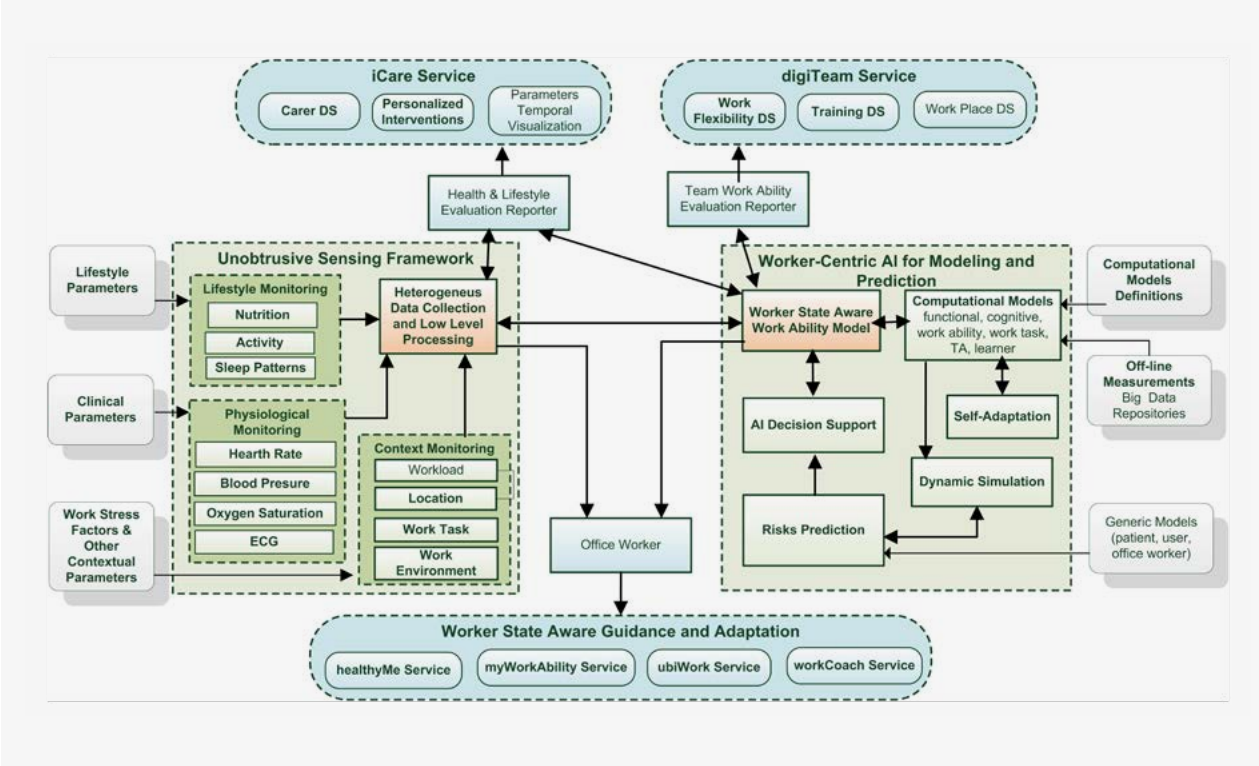

Figure 1: Concept SmartWork AI system

Research on user requirements

The SmartWork system will be tested in Portugal and Denmark in several pilots in office environments. To develop the system, we performed a desk study and end-user consultation among Portuguese and Danish older office workers, employers/managers and caregivers of older workers in order to define the user needs.

Online questionnaires in English, Danish and Portuguese language were used to learn more about work and preferences from the engaged stakeholders. From Aarhus Municipality (Denmark) 49 office workers participated, from Cáritas Coimbra (Portugal) 50 office workers from the appropriate age-group responded. Their results were compared with the 60 respondents from several other European countries, mainly The Netherlands, Greece and Finland. Next to the employees, 12 Portuguese and 10 Danish employers/managers filled in the questionnaire. From both countries 10 caregivers each participated.

Consulted on their preferences for the SmartWork AI system, older workers most value as useful or very useful an application that informs on meetings and events, provides guidance, reminds on appointments, provide training contents, transfers work between devices and manages or organises the work. From the European questionnaire most preferable feature would be to have a device that automatically chooses individual settings. Not very useful or not useful at all for the Danish and Portuguese employees consulted, are applications that check the health status every minute, every day or every week. Also, they don't find interesting if this system provides company, reports about the working time at the computer or informs the boss on the performances. The SmartWork system should preferably become available on a smartphone or on desktop/laptop. The most preferred interaction should be by keyboard, touch screen, sensor, speech or pictograms.

Regarding the preferred functionalities of the SmartWork system, Danish employers show quite opposite meanings compared with their Portuguese colleagues. Where Portuguese employers would like to have a system (from most favourite to least) that supports on the fly work practice, identifies training needs, identifies needs for workplace adaptations, supports with optimal employee pairing, reports health and condition of the worker and reports on progress, the majority of Danish employers finds these functionalities not very useful or not useful at all. Danish caregivers however, were more positive on SmartWork assets referring their higher preference for a system that provides information on health risks and monitors the status of the worker they care for.

SmartWork will be piloted in Portugal and Denmark for about 20 months with 72 older office workers, managers and caregivers. Results are expected early 2022.

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Healthy aging at work: Trends in scientific publications

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Keywords:
healthy aging at work, active aging, older adults

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For the increasingly aging populations in many developed countries healthy aging and wellbeing has become a major concern. Therefore, in this paper we apply NLP-based methods for automatic analysis of abstracts of scientific publications to identify trends in academic publishing. We analysed articles indexed in the IEEE Xplore, PubMed, and Springer digital libraries in accordance to the PRISMA surveying methodology adopted for scoping surveys. By identifying keywords and properties relevant for this topic, we aimed to identify the papers that contain them and then to determine whether there are any general trends.

First, all three libraries were searched with the following keywords "successful aging at work", "active aging at work", "healthy aging at work", "productive aging at work", "technology for active aging at work", "older adults at work", and "successful aging in gerontology and life span psychology". Figure 1 shows the distribution of identified potentially relevant papers based on these keywords.

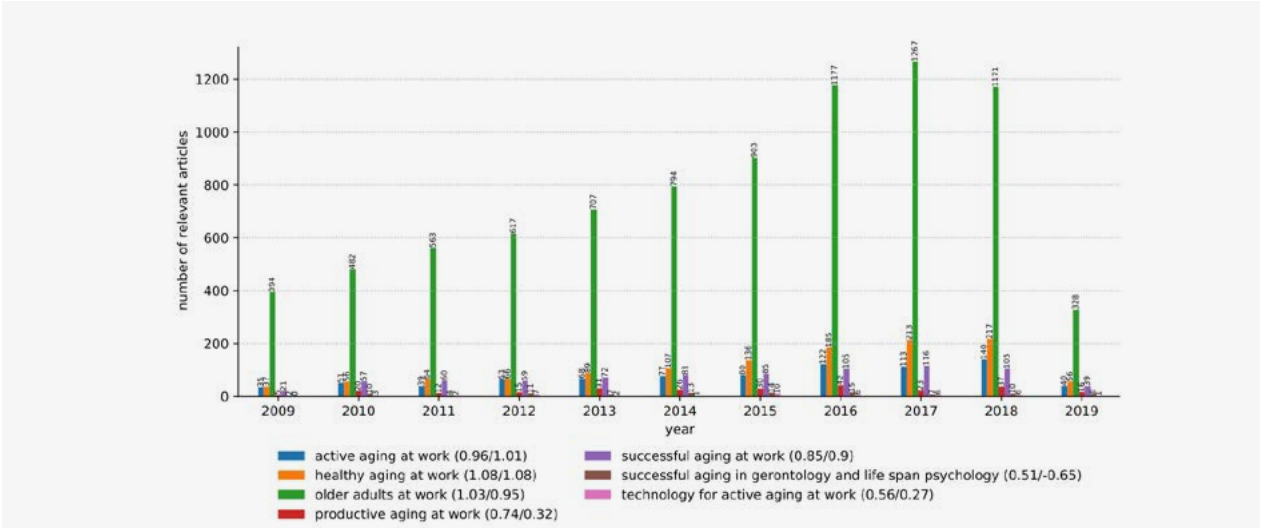

Figure 1: Found papers with the searched keywords related topics trends per digital library

Then, we analysed the identified potentially relevant articles from the perspective of different topics: Proactive behaviour, Subjective and objective criteria for successful aging, Explanatory mechanisms, Facilitating and constraining factors, Temporal patterns, Life style, Study types, Job characteristics, Medical conditions, Job problems and concerns, AI topics, and Smart applications. For each of these topics, several properties were identified and then we tagged articles whether they contain those topics or not.

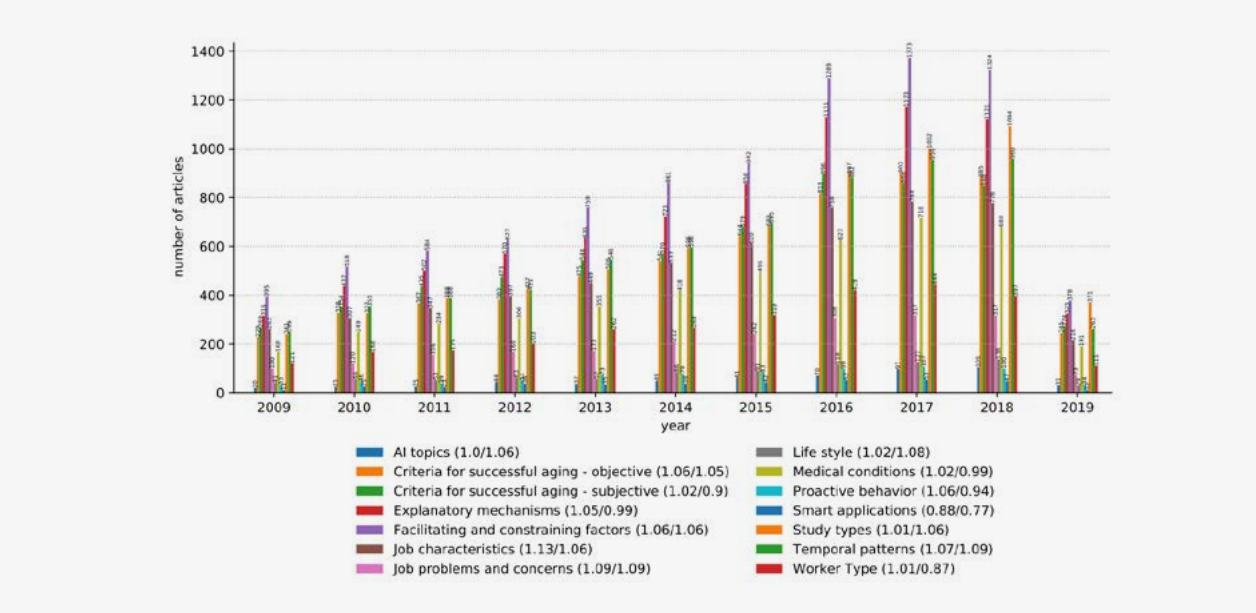

Figure 2

There is a clear increasing trend in publications in almost all topics related to healthy aging at work.

Based on the initial results we observe that the increment in the publications per year is significant and that each year, the attention towards the problem of healthy aging by the scientific community is increasing. Furthermore, we observe that most of the publications discuss the facilitating and constraining factors in the working environments and the explanatory mechanisms in the environment. Of note, there is a lack of publications concerning smart applications that address healthy aging at work and this topic does not follow the general trend in publication growth.

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Technology Adoption
Sub-Working Group 4.4 Proceedings

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Second Sheld-on conference meeting
Proceedings Book

Challenges in building AI-based connected health services for older adults

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Keywords:
artificial intelligence, connected health, data science, digital inclusiveness, older adults

Artificial intelligence (AI) refers to systems manifesting intelligent behaviour by analysing their environment and taking actions, with some degree of autonomy, to achieve specific goals (COM 237 final. 2018). AI-based systems can be software-based, such as voice assistants, image analysis software, and face recognition systems, or embedded in hardware devices, such as medical robots, autonomous cars, and Internet of Things (IoT) applications. AI today is helping to solve some of the biggest global challenges, from treating chronic diseases or reducing fatality rates in traffic accidents to fighting climate change or anticipating cybersecurity threats (COM 168 final. 2019).

Connected health (CH), as a new paradigm, manages individual and community health in a holistic manner by leveraging a variety of technologies and has the potential to incorporate telehealth and integrated care services, covering the whole spectrum of health-related services addressing both healthy subjects and chronic patients (Mountford et al. 2016). CH services here directly address patients and citizens at large in managing the disease or health and wellness, and the reorganization of which expects to bring high impact in the health care domain (Chouvarda et al. 2019).

The EU population will increase from 511 million in 2016 to 520 million in 2070, but the working-age population (people aged 15-64) will decrease significantly from 333 million in 2016 to 292 million in 2070. These population structure projections reflect assumptions on fertility rates, life expectancy and migration flows. The old-age dependency ratio (people aged 65+ relative to those aged 15-64) in the EU will increase by 21.6 percentage points, from 29.6% in 2016 to 51.2% in 2070. This implies that the EU would go from having 3.3 working-age people for every person aged 65+ to only two working-age persons (COM ip 079. 2018).

Digital technologies and artificial intelligence will be vital tools in achieving universal health coverage (UHC), as expanding public and private sources of data and improving and expanding tools to analyse, visualize and model data increasingly allow researchers and policy-makers to identify patterns, problems and evidence for action (WHO, 2018). This work analyses the challenges in building AI-based connected health services for older adults in order to provide the satisfactory results towards achieving UHC.

The analysis addresses not only AI-related challenges, such as lack or imbalance of datasets and lack of domain knowledge about algorithms reliability, but also privacy and confidentiality risks, as well as ethical challenges. We address the challenges in building AI-based connected health services for older adults from the following perspectives given below (Table 1).

No.	Challenge groups
1	Health-related: patient triage and screening options, treatment options, clinic workflow
2	Target user group-related: availability of training data, normalized acquisition parameters
3	AI-related: data gap and visualisation, imbalance of datasets, data labelling and analysis
4	Development process-related: skill gap between software engineers and data scientists
5	Domain knowledge-related: lack of AI expertise, privacy and confidentiality risks, ethics

Table 1: Challenges in building AI-based connected health services for older adults

We approach the given challenges by applying Connected Health Impact Framework (Chouvarda et al. 2019) and analysing them through the following axes: service description, user, outcome, and value proposition. Being oriented more to the older adults, we look deeper into barriers and enablers for building such AI-based connected health services. Finally, we map the challenges with the wearable technology options (Loncar-Turukalo et al. 2019) that can make connected health services for the older adults more effective and efficient, by fitting into their life surroundings better. As healthcare seems to be one of the most attracted areas for applying AI (Jiang et al. 2017), we address the opportunities as well as obstacles to its current usage.

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Connected health and wellbeing for people with complex communication needs

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complex communication needs, connected health, wellbeing, assistive technologies, digital inclusiveness

World Health Organization (WHO) defines universal health coverage (UHC) as its priority objective in ensuring that all people have access to needed health services, including prevention, promotion, treatment, rehabilitation and palliation, of sufficient quality to be effective while also ensuring that the use of these services does not expose the user the financial hardship. WHO also reported (WHO 2016) that more than 50% of its member states have an e-health strategy, and 90% of e-health strategies reference the objectives of UHC or its key elements.

The term "e-health" is defined as the transfer of health resources and health care by electronic means. It encompasses three main areas: (1) the delivery of health information, for health professionals and health consumers, through the Internet and telecommunications; (2) using the power of IT and e-commerce to improve public health services, e.g. through the education and training of health workers; (3) the use of e-commerce and e-business practices in health systems management (WHO 2016). With more involvement of the electronic systems and information and communication technology (ICT) in offering health services, the major international organizations, such as European Union (EU), International Telecommunication Union (ITU) and European Space Agency (ESA) have officially adopted the denomination "e-health". It refers to the use of modern information and communication technologies to meet the needs of citizens, patients, healthcare professionals, healthcare providers, as well as policy makers (EUMD 2003).

Connected health is a paradigm shift looking after the individual and community health in a process that speaks to the health journey of the person through the entire lifespan leveraging a variety of technologies to do so (Mountford et al. 2016). It has been coined in recent years to encompass various terms describing different advances in health care enabled by ICTs, such as e-health, digital health, m-health, tele health, telemedicine, remote care, and assisted living. The new concept of health management includes devices (such as sensors and wearables) and services, as well as interactions (e.g. interventions) designed with a patient in the centre.

We consider the concept of connected health and wellbeing (CHW) as an upgrade that deals with person's journey through life not only considering health, but also wellbeing aspects, such as positive relations with others, autonomy and self-acceptance. People with complex communication needs (CCN) are not fully able to deal with everyday communication situations by using only speech. They have trouble with producing or understanding speech, which can also involve difficulties with reading and writing. Nevertheless, they also need to learn and utilize the technologies that empower them and enable the health and wellbeing status of every individual is fully accepted, along with his/her capabilities (Belani et al. 2016).

This work analyses the aspects and challenges of connected health and wellbeing for people with complex communication needs, especially targeting the older adults. The addressed research questions on CHW for people with CCN are given below (Table 1).

No.	Research questions
1	Which are the aspects of wellbeing? How they relate to health? What does it mean to older adults?
2	What is the concept of connected health and how to apply outside the health domain?
3	How are people with complex communication needs achieving their wellbeing? Which criteria have to be met?
4	How does connected health and wellbeing technologies help people with complex communication needs achieve digital inclusiveness? What accessibility and usability requirements have to be met?

Table 1: Research questions on connected health and wellbeing for people with CCN

In order to tackle these questions, we examine the role of ICTs and connected health technologies in achieving digital inclusiveness, in order to promote inclusion and equality in society for people with CCN and older adults who need support in understanding, communicating and learning how to achieve and maintain their health and wellbeing. We aim to learn from the area of clinical practice called augmentative and alternative communication (AAC), in order to build solutions that enable connected health and wellbeing environment for people with CCN (Vučak et al. 2012).

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Analysis on competences and needs of senior citizens related to domotics

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Introduction: The European SmartyourHome project aims to enable older adults to understand the characteristics and possibilities of digitalisation linked with smart-home concepts and to make active use of them. The project started with a competences & needs analysis of the target group regarding the topic of smart home, the results will be reported here. Method: Collecting data followed two strands: First strand, an online-survey conducted with 176 older adults from Germany, Romania, Spain, Italy and Ireland (Table 1). It included 19 questions (free text or yes/no). The survey period covered 4 weeks. Second strand: Focus Groups were carried out in the same countries. The Focus Group method was intended to provide further in-depth insights in order to widen the perspective by qualitative means. Using this method allowed to make personal and direct contact with the seniors and to obtain a richer picture of the older adults' feelings and attitudes on the issue of smart home. Sample: Since, to date, older adults just come in contact with smart home technologies, the project obviously deals with early adopters. So, the sample is limited to older adults with affinity towards technology. The results of this pilot study cannot be transferred to older people in general. Recruitment, both the survey and the focus group, took place via networks of the partners covering organisations that deal with open minded older adults.

Items	Germany	Romania	Spain	Italy	Ireland	**Total**
Respondents	24	23	80	29	20	**176**
Rdvanced/ experts	18	6	28	7	16	**75**
Under 60 years	14	14	10	4	14	**56**
60-70 years	8	7	37	11	3	**66**
Over 70 years	1	2	33	13	3	**52**
Female	7	9	45	13	13	**87**
Male	16	14	35	15	7	**87**

Table 1: Target group characteristics

Across all countries, not only men took part in this technology related survey, but in Spain and Ireland even more women than men. The interviewees' age range was 50 to 90 years (see table 1), with almost all of them living in rented flats or their own houses, primarily in urban areas or conurbations. Results: Most of the respondents consider their ICT skills to be relatively low, but there are again two different groups: in Germany, Ireland and Spain the percentage of older adults who have no experience with computers, tablets or smartphones is low (below 5%), there are beginners, advanced and even "experts" among them. In Romania and Italy, on the other hand, the number of older adults years without ICT skills is much higher (around 20%), with most of them being beginners, few advanced and no experts. This means

that in these countries the knowledge about smart home is still very low, smart devices are nearly not used by older adults. For this reason, the participants in Romania, Italy and even Ireland skipped the more specific questions on the concrete use of smart home applications. Only Spain and Germany have provided answers here. Some smart home devices are there already partly in use, but the programming and use of so-called micro-controllers is no issue yet. Although many respondents in the partner countries have low ICT knowledge (see Schreurs et al. 2017), interest in smart home is relatively high; however, in some countries very few can imagine participating in the project further. The lack of initial ICT skills prevents a deeper involvement with new technologies. The interests of older adults in smart home application sectors can be summarised as follows (table 2):

Applications	Germany	Romania	Spain	Italy	Ireland	**Total**
Automation/ comfort	4	5	5	4	4	**22**
Home security	3	2	3	1	3	**12**
Health	5	1	2	2	5	**15**
Energy	1	4	1	3	1	**10**
Entertainment/ communication	2	3	4	5	2	**16**

Table 2: Interest in smart home applications (priority: 1 =most interest; 5= least interest)

Smart services related to energy seem to raise most interest whereas home automation and comfort are ranked low. Of course, there are also concerns about these services: data protection/ hacking/privacy, complexity, high costs, doubts about utility and usability are the most frequent. Nevertheless, participants would be willing to pay for smart home services (100-3000€) (see AAL study, 2017). The above results guide the course creation, a mix of learning approaches will be applied (face-to-face, online course, self-study, hands-on) with up to four learning hours per week. Participants from Germany, Ireland and Spain would be happy to act as eTutors.

Following the results of the study, guiding principles for the course concept will be: Easy handling & operation of the applications; explanations and instructions of Smart-Home issues on a basic level; self-assessing the usefulness of smart home devices; reduce distrust & fears towards Smart Home; provide assistance and contacts; starting on a very basic level with softly increasing difficulty. Although the majority of participants were relatively unfamiliar with smart-home concepts, they were able to point out benefits and concerns regarding this technology. There is a perceived openness from both, survey and focus group participants to further engage with smart home technology. This is a promising base for the course offer to be developed in the project.

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Comparison of technology adoption models

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Keywords:
technology adoption models, acceptance of technology

The number of technological solutions for the older adults proposed and available on the market is growing. However, some solutions are not widely applied and do not reach the market goals. Moreover, all technological advancements are accepted by some users and rejected by others. There are several technology adoption models, that try to explain, how and why the technologies are adopted and used. Among those, that are widely used to explain, how the older adults accept technologies, there are some general models and models specific to the group of older users. Among the general ones I would recommend paying attention to the following models: Technology Acceptance Model (TAM) proposed by Davis (Davis, 1989), Extended Technology Acceptance Model (TAM2), Extended (contextual) Technology Acceptance Model (TAM3) and Unified Theory of Acceptance and Use of Technology (UTAUT). Among the ones specific for the group of older users there are: Senior Technology Acceptance Model (STAM), Extended Technology Acceptance Model for the Elderly (ETAME), Model of Technology Adoption by Older Adults (MATOA) and Elderadopt. The models were identified with the literature review held by SHELD-ON participants (Sheld-on, 2019). This paper provides a brief comparison of the models.

Common concepts

Within the models there is a set of common basic concepts, that represent, although sometimes named differently, the same variable (attitude or behaviour). The basic concepts include: perceived usefulness, perceived ease of use, attitude towards using, behavioural intention to use and actual system use. The concepts coverage within the models is presented in table 1.

Concept	TAM	TAM2	TAM3	UTAUT	STAM	ETAME	MATOA	Elderadopt
Perceived usefulness	x	x	x	x[a]		x		x[b]
Perceived ease of use	x	x	x	x[c]		x		x[d]
Attitude towards using	x					x		*
Behavioural intention to use	x	x	x	x		x	x	*
Actual system use	x	x	x	x				*
External variables	x[e]	x[f]	x[f]	x[f]	x[f]	x[f]	x[f]	x[f]

Table 1: Basic common concepts in technology adoption models

*[a]called Performance expectancy, [b]called Appraised Efficaciousness, [c]called Effort expectancy, [d]called Appraised Usability, [e]general concept of "external variables", [f]model-specific list of variables, *a different set of concepts was proposed that are not directly equivalent to the basic ones, although cover them as a set*

The most important notice about the basic concepts is the distinction between the attitude towards using, behavioural intention to use and the actual system use. The developers of the technologies frequently miss the difference and while measuring "attitude towards using" concept only, they make prediction on sales and are surprised after the product is launched.

In addition to the basic concepts, each model defines a list of external variables, partially explaining variability of acceptance among users and technologies. The external variables generally fall into the following categories: personal characteristics of a user (age, gender, condition, experience with technology etc.), technology features (i.e. system quality, task structure) or contextual characteristics (social support, voluntariness of use, etc.). The lists of external variables proposed by different models are provided in Table 2.

Model	External variables influencing adoption of technologies
TAM	only a general concept of "external variables"
TAM2	voluntariness, subjective norm, experience, image, job relevance, output quality, result demonstrability
TAM3	TAM2 list + others use, system quality, organizational support, prior experience, anxiety, task structure, computer efficacy
UTAUT	voluntariness, experience, social influence, facilitating conditions, gender, age
STAM	social influence, gender, age, education, income, health satisfaction, movement ability
ETAME	experience, gender, age, narrative, social, physical
MATOA	anxiety, social influence, gender, age, education, physical, requisite knowledge, social support, self-concepts, self-management, self-compensation
Elderadopt	perceived stressfulness of individual's unmet needs, individual resilience, persuasiveness of external information, persuasiveness of internal information

Table 2: External variables in technology adoption models
Note: each of the variables explains only a small portion of variance in the intention of use and the consumer behaviours

Elderadopt model, that is an adoption of psychological theory of appraisal to adoption of technologies by the older adults, is unique in the following issues: (1) it starts not with the technology itself, but with the individual appraisal of unmet needs (a problem); (2) it takes into account alternative solutions (traditional coping solutions); (3) it shows that a user might perform action strategies (choosing to adopt the proposed or an alternative solution) or mind strategies (change goals, change needs assessment, resignation or denial). The use of the appraisal theory makes the model unique and perhaps the one to use if a context of technology is to be analysed.

Summing up, the comparison of the models brings some key advice. Firstly, distinguish between the concepts of the attitude towards using, behavioural intention to use and the ac-

tual system use and be aware, which one you are actually measuring. Secondly, include a reasonable list of external variables, perhaps mixing models, if needed. Thirdly, if analysing problem and context of use and not specific

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Choice architecture to promote the adoption of new technologies

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technology adoption, promotion, choice architecture, status quo bias

It is difficult to predict to what extent and how fast new technologies will be adopted. Amongst older adults, we know technology adoption lags behind many other demographics (Lee and Coughlin 2015). This poses significant barriers in delivering solutions to a user group that can benefit significantly from recent advances in robotics, artificial intelligence, Internet of Things, and other digital assisted living technologies.

Technology adoption is limited due to many factors, including privacy and security concerns, as many of the solutions monitor users (i.e., for fall detection or to predict health events) and therefore mean collecting and sharing personal data (Chaudhuri et al. 2014). Issues around stigma, access to support, and anxiety about using devices are barriers as well (Chaudhuri et al. 2014). Solutions for older adults may be further limited because product designers (typically younger, technologically capable adults) may not be closely familiar with the characteristics and needs of the intended users (older adults) (Lee and Coughlin 2015). Recent strides in requirements engineering may help bridge the gap between the needs perceived by designers and the actual physical and emotional needs of the users (Taveter et al. 2012; Lopez-lorca et al. 2014). If user needs are addressed well by a solution, what can be done to improve its uptake?

One of the major obstacles stalling technology acceptance across all demographics stems from human cognitive biases. Particularly responsible is the status quo bias, where the current state of affairs is preferred and any change from that state is perceived as a loss (Samuelson and Zeckhauser 1988). Users may therefore resist adopting the new technology even if it can address their needs (Kim and Kankanhalli 2009). In healthcare facilities, for example, potential users sometimes resist adopting technologies that could considerably improve organizational functioning (Bhattacherjee and Hikmet 2007). Widespread implementation of assistive technologies for older adults may face similar adoption resistance. For instance, it has been observed that resistance to change in older adults is associated with lower willingness to adopt preventative mobile health services (Hoque and Sorwar 2017). Promoting the use of technology can thus provide only limited gains if it is based only on technological aspects and does not consider user resistance fuelled by the status quo bias.

A recent study has demonstrated how a slight manipulation in the choice architecture – the way choices are presented – can alleviate such user resistance and nudge people to more frequently favour the new technology (Stryja et al. 2017). Thoughtful design of choice architecture thus has the potential to decrease the older adults' resistance to adopting helpful assistive technologies. The presentation of choices could be improved with greater understanding of the general human nature and the specific characteristics of the target users. The insights elicited during the requirements engineering phase could not only be useful in designing products but also in designing choices that the intended users will face.

Our analysis of choice architecture design will include the strengths, weaknesses, opportunities, and threats (SWOT). Carefully structured choices can provide guidance in decision-ma-

king process, but it may not be easy to design them. And while devising choices offers many opportunities for positive change, it is important to be mindful of the potential risks when the choice architecture does not act in the best interest of users.

In the world of behavioural economics, it has long been recognized that humans are rarely rational agents, whose decision-making hinges on careful analysis of the available evidence. Human biases have long been exploited in modern advertising that often encourages activities that are harmful to health. Similar approaches could be applied to promote health benefiting activities and tools, including the use of assistive technology, which must be adopted more widely to achieve the greatest impact. One valuable tool may be carefully designed choice architecture that accompanies a technological solution in the promotion phase.

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Swallowing the bitter pill: Emotional barriers to the adoption of medicine compliance systems among older adults

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Keywords:
medicine compliance systems, older adults, requirements elicitation, motivational modelling, emotional requirements

Medications are the primary tools used to prevent and effectively manage chronic conditions. However, despite their importance and benefits, appropriate medication usage remains a challenge for both patients and healthcare providers. Patients frequently do not adhere to essential medications, resulting in poor clinical outcomes and increased cost of care. The total cost estimate for non-adherence ranges from 100-300 billion USD each year in the USA alone, and includes both direct and indirect costs.

Non-adherence also increases the burden imposed on informal family caregivers. Although prevalent in all age groups, the challenge is much more complex when it comes to the elderly population, who suffer from higher rates of chronic conditions.

Different systems have the potential to assist with medicine compliance by organizing medications, reminding patients to take their medications and even by communicating compliance statuses to medical practitioners or caregivers. These systems range from simple pill organizing boxes to fancy systems based on sophisticated technologies. While many solutions exist, medicine compliance remains a problem for many people. Adoption rates of medicine compliance systems are low and initial enthusiasm is frequently followed by declining usage as time passes.

Appropriation of a medicine compliance system is driven by a variety of emotions, depending on user status, whether they are actually using the system, or on the phase of the decision-making process about adoption of the system.

A medicine compliance system that is imposed on a user by, for example, informal caregivers, is not accepted positively unless there is a wide spectrum of positive emotions that empower the decision-making process by the user. Emotions such as assurance, sense of freedom, anticipation, obligation, and compulsion impact the decision-making process about the adoption of a medicine compliance system. Therefore emotional requirements should be explicitly considered during system design and implementation to encourage appropriation and avoid rejection of systems.

We have examined behavioural, cognitive and emotional barriers to using medicine compliance systems for trying to understand why medicine compliance systems have not been the success that they were initially expected to be. For holistic consideration of different aspects of using medicine compliance systems, including emotional ones, we propose to elicit and represent requirements for medicine compliance systems in terms of three types of goals: hierarchy of functional goals or 'Do' goals and attached to them quality (non-functional) goals or 'Be' goals and emotional goals or 'Feel' goals (Miller, Pedell, Sterling, Vetere, & Howard, 2012; Lorca, Burrows, & Sterling, 2018; Sterling, & Taveter, 2009). Eliciting and representing emotional requirements as first-class citizens has been proposed by Miller, Pedell, Lopez-Lorca, Mendoza, Sterling, & Keirnan (2015). The notation for 'Do', 'Be' and 'Feel' goals is depicted in Figure 1.

Figure 1: Notation for 'Do', 'Be' and 'Feel' goals

Figure 2 shows a part of the results of the requirements elicitation sessions for an "ideal" medicine compliance system that were conducted by the authors of this paper based on an extensive literature review. The goal model represented in Figure 2 and other goal models created will be explained in the presentation.

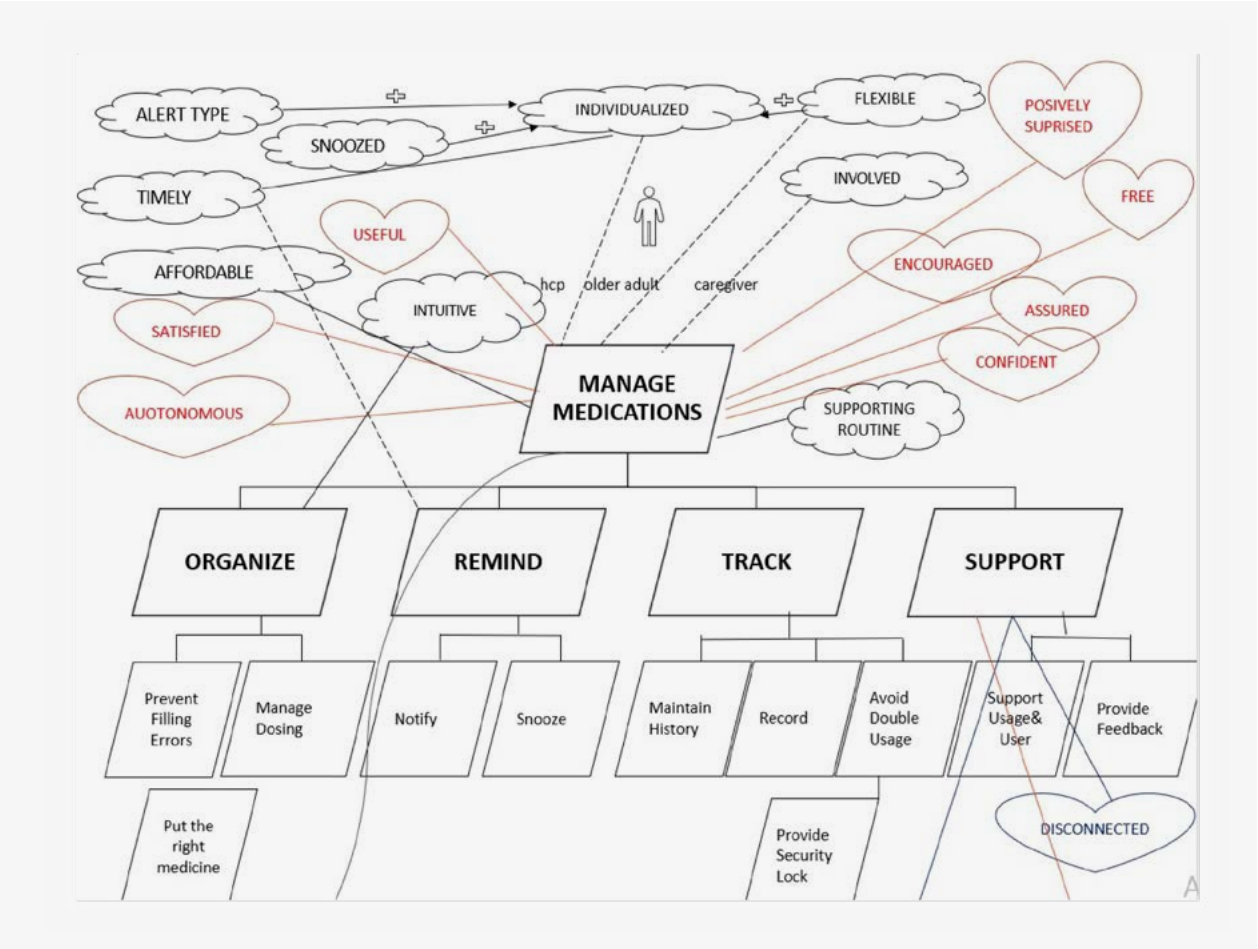

Figure 2: The results of applying the 'Do'/'Be'/'Feel' method tomedicine compliance systems based on the literature review

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An edge computing robot experience for automatic elderly mental health care based on voice

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Mental health care and diagnosis are today migrating towards mobile solutions (Bakker et al. 2016). The interest and techniques were already under study considering multiple aspects, from acceptability to clinical efficacy, through targeted therapies and clinical benefits (Simon and Ludman 2009). Mobile applications provide a more accessible support (Watts and Andrews 2014). This becomes particularly interesting, knowing that people dealing with mood, stress, or anxiety not always seek professional help or get care when it is really needed (Mojtabai et al. 2002). On the other hand, care or help is not always available when needed, for reasons such as location, financial averages or for societal reasons (Collin et al. 2011). We need open platforms driven by specialists, in which queries can be created and collected for long periods and the diagnosis made, based on a rigorous clinical follow-up. In this work, we developed a multi-language robot edge computing embedded interface helping to evaluate the mental health by interacting through questions.

Voice-enabled technologies are leading multiple domains, integrated in products that are part of our everyday life, from cars to home automation (Brownstein et al. n.d.). Although commercial products such as Microsoft Cortana, Amazon, Google Home or Sonos are not always open to customization, they are supported by development platforms, as in the case of Amazon AWS (AWS 2019), Google (Cloud 2019) and IBM Watson (IBM.Watson 2019), for example. According to (Van Der Straten, n.d.), the healthcare sector is the most popular category (47.1%) for vertical voice-based applications. Telemedicine encourages conversation applications in the health field, particularly where hospitals have a strong incentive to provide high quality follow-up care. Thus, the high cost of physicians and caregivers is spent on hours of data collection in electronic health records. The voice health sector also extends to seniors who wish to stay at home, especially those who refuse mobile or smart technologies requiring dexterity or good vision (Brownstein, Lannon, and Lindenauer n.d.). Aging at home implies socializing, AI-based activity oriented interfaces and daily monitoring services. Robot-based, patient-caregiver, communication saves time and therefore increases the productivity of already planned tasks such as remainders and appointments. Physician notes, such as the Electronic Health Record (EHR) and patient feedback, now use voice technology and AI-based natural language scribes (Kiroku 2019) on multiple platforms (PC, smartphones), including new microphones and wearable voice interfaces (Notable 2019).

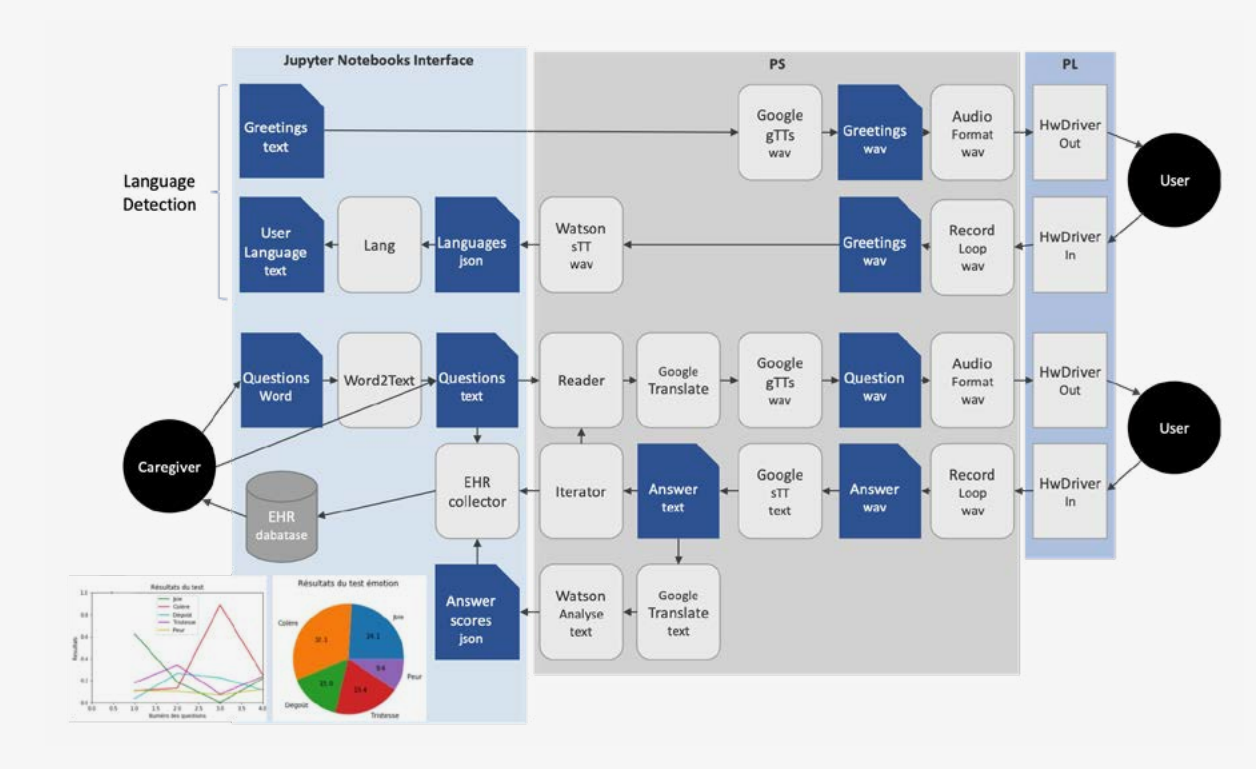

Figure 1: Healthcare home hands-free voice device system architecture. The edge-computing embedded system is composed of three sections: Jupyter WEB interface, Programmable Software PS and Programmable Logic PL. The PL part uses real-time audio procession interfaces for user interaction using a headset. Jupyter allows to recover results in text and graphical form. The first task of the system is to recognize the user language. The second steps to process the questions list that is used to fill the HER collector and database with the user answers.

Healthcare voice-enabled mobile applications such as MIMOSYS (Medical-pst 2019) and CHADmon (Antosik-Wójcinska et al. 2019) monitor mental health or disorders related to emotional changes through the analysis of the human voice. Several healthcare platforms are working with Amazon Alexa and Google Assistant smart speakers, for instance, Cuida Health LISA (CuidaHealth 2019). Many are actually hands-free voice devices, such as Rosie Reminder (Smpltec 2019) and ElliQ (Elliq 2019), others are wearable, as Notable (Notable 2019). In this work, we developed a multi-language robot interface helping to evaluate the mental health by interacting through questions. The specialist can propose questions, as well as to receive users' answers, in text form. The robot can automatically interact with the user using the appropriate language. It can process the answers and under the guidance of a specialist, questions and answers can be oriented towards the desired therapy direction. To build a hands-free voice device, we target an edge computing embedded system (Fig. 2). The prototype, was implemented on an embedded device, a Xilinx PYNQ-Z1 board (Xilinx 2019), designed to be used as an open-source framework anywhere at home. That system combines hardware libraries for audio processing and a Python program running on an ARM A9 CPU. The software part is programmed using Python libraries from Google Cloud (Cloud

2019) (translate) and IBM Watson (IBM.Watson 2019) (speech, empathy and natural language), all in a Jupyter Notebook development environment. The platform can be accessed through a Web server hosting the Jupyter Notebooks design environment that includes the IPython kernel and packages running on a Linux OS. The experience is now available for specialists to create queries and answers through a Web-based interface. Queries can be created and collected for long periods and the diagnosis made, based on a rigorous clinical follow-up.

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